NEW ZEALAND AND SOUTH-EAST AUSTRALIAN ILYARACHNINAE (ISOPODA: ASELLOTA: MUNNOPSIDAE) AND THEIR WORLDWIDE RELATIONSHIPS

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"It was certainly not a very pleasant work to be dabbling with naked hands in the water with the temperature down to -5 Fahr. But when our fingers tingle the most and are stiff and numbed with cold, we have this to comfort us, that we are suffering for the cause of science, and that many zoologists are waiting for the results we shall bring back and thank us accordingly."

Nicolai Hanson, May 10th 1899, Zoologist with the *Southern Cross*.

To all those who have collected and sorted the material which I have worked with in this study, thank-you.

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Abstract

The diversity of New Zealand and Australian asellote isopods remains largely unknown. Even less is known about how this fauna is related to the rest of the world. This study focuses on the munnopsid subfamily Ilyarachninae Hansen, 1916, to explore the phylogenetic and biogeographic relationships of the local fauna to others from this group worldwide.

To analyse the relationships within the Ilyarachninae, a suitable outgroup, in this case, the sister group, was needed to be determined. To do this, a cladistic analysis of the Munnopsidae was undertaken. In addition to determining a suitable outgroup, the family level analysis also served to test the monphyly of the nine subfamilies and to resolve the placement of the three genera, *Munneurycope* Stephensen, 1913, *Munnicope* Menzies and George, 1972 and *Munnopsurus* Richardson, 1912b which were not placed in any exsiting subfamily. The cladistic analysis of the Munnopsidae included 72 species representing all munnopsid genera, including where possible, the type species and was based on 122 morphological characters. A well resolved strict consensus tree was found. The results show *Munnopsurus* to be the sister group of the Ilyarachninae and the Munnopsinae to be the most ancestral group of the Munnopsidae. Of all the subfamilies, the Betamorphinae is not a monophyletic. The results show that although some subfamily names are upheld, others show no congruence to the topology of the results, and therefore the use of subfamily names are abandoned. Four families are instead recognized, the Munnopsidae (restricted to the former Munnopsinae), Acanthocopidae Wolff, 1962, the Syneurycopidae Wolff, 1962 and the Lipomeridae Tattersall, 1905a, with the latter including the former Ilyarachninae (‘*Ilyarachna*-group’).

Within the *Ilyarachna*-group, two new genera and 28 species were described, including 25 species new to science. Two genera, *Notopais* and *Epikopais* n. gen. are found exclusively in the southern hemisphere. Of the more cosmopolitan genera, some New Zealand and south-east Australian species display close affinities to each other and with Antarctic species. These relationships were tested using cladistic phylogenetic methods, and in addition to

this, the analysis also served to test the monophyly of the genera. The analysis used 59 species, representing all genera and 61 morphological characters. The strict consensus tree was well resolved, however *Aspidarachna* Sars, 1897b, *Ilyarachna* Sars, 1870 and *Echinozone* Sars, 1897b were not monophyletic. The results also showed that the *Ilyarachna*-group fauna of New Zealand and south-east Australia are closely related to each other and to species from Antarctica.

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I have wanted to be a marine biologist since I was in Grade 5 in primary school and as I sit here and write this, I have to pinch myself to realise I am nearly there. My interest in deep-sea asellotes stems from doing my honours project in Gary Poore's lab at Museum Victoria (Melbourne, Australia), where I worked on the family Ischnomesidae. I can recall a conversation on the topic of future Ph.D. study and Gary's suggestion that I could go to New Zealand to do one. I can remember the feeling of horror at the thought of moving that far away from home (with home being Melbourne, Australia). Funny how things turn out.

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Chapter 1: General Introduction

The suborder Asellota makes up 33% of the world's described aquatic isopod species. In New Zealand and Australia, this proportion is much lower. In New Zealand, asellotes make up 18% of the total described aquatic isopod species (Merrin 2004a), while in Australia, asellotes make up only 9% of the total described aquatic isopod species (Poore 2002; Poore 2005).

1.1 Introduction to the family Munnopsidae

Of all the asellote marine families, the Munnopsidae Lilljeborg, 1864 is the largest with close to 300 known species. The first munnopsid isopod species, *Munnopsis typica* Sars, 1861, was described by Norwegian Michael Sars who collected material from Norway. In the south-west Pacific, the first munnopsids were collected by the H.M.S. *Challenger* and were described by English scientist Frank Beddard. He described two species, *Vanhoeffenura novaezelandiae* (Beddard, 1885) and *Munnopsis gracilis* Beddard, 1885, both of which were collected from off New Zealand.

What we now consider to be the Munnopsidae was defined by Wilson (1989). As a result of his phylogenetic study, he brought together three existing families, the Munnopsidae, the Eurycopidae Hansen, 1916 and the Ilyarachnidae Hansen, 1916 on the basis of three characters that he found linked these groups. These three synapomorphies are: the presence of natapods and the associated musculature for swimming; trough-like dactylar unguis that encloses two sensillae; and the flattened first article of antenna 1 (Wilson 1989). Within the Munnopsidae, Wilson (1989) defined seven subfamilies: Acanthocopinae Wolff, 1962; Bathyopsurinae Wolff, 1962; Eurycopinae; Ilyarachninae; Lipomerinae Tattersall, 1905a; Munnopsinae; and Syneurycopinae Wolff, 1962 which contained all but seven genera, genera which he could not place in a subfamily and therefore left as *incertae sedis*. Kussakin (2003) later revised the Munnopsidae and established an additional two subfamilies: Betamorphinae Kussakin, 2003; and Storthyngurinae Kussakin, 2003, leaving only three genera,

Munneurycope Stephensen, 1913, *Munnicope* Menzies and George, 1972 and *Munnopsurus* Richardson, 1912b as *incertae sedis*.

At the start of this study the Munnopsidae consisted of nine subfamilies, 36 genera and close to 300 known species.

1.2 Morphology of the family Munnopsidae

Morphologically, munnopsid isopods exhibit a wide variety of shapes and sizes, but nevertheless, they have the same general body plan (see Fig. 1.1).

Cephalon.– The cephalon varies in shape from being trapezoid in the Ilyarachninae to rectangular in the Eurycopinae. Ornamentation being either setae or varying numbers of spines can be present. The cephalon is usually not fused to pereonite 1 except in *Syneurycope* Hansen, 1916. Eyes are always absent. At the front of a cephalon, the frontal arch can be either present (for example in the Ilyarachninae), incipient (for example in the Munnopsinae) or absent (for example in the Eurycopinae) (Wilson 1989). Below the frontal arch is the clypeus. Beneath the clypeus is the labrum, which sits on top of the mandibles.

Body. – The body consists of two parts, the ambulosome (pereonites 1–4) and the natasome (pereonites 5–7 and the pleon). The relative size of the ambulosome compared to the natasome varies amongst the groups. While pereonites 1–4 are free and articulating (except, as previously mentioned, in *Syneurycope* where pereonite 1 is fused to the cephalon), various levels of fusion occur between pereonites 5–7 and the pleon. Fusions characters have been used to define subfamilies and genera. Dorsal ornamentation in the form of spines on some or all of the pereonites is commonly seen in many groups. Robust setae are also known to occur on anterior margins of pereonites 1–5 in some species. Laterally, pereonites 5–7 can extend out into narrow spine-like extensions.

Pleonite 1.– Generally always defined, except in those groups where the natasome is fused, for example in species of Storthyngurinae.

Pleon.– Varies in shape from triangular to oval, dorsal, lateral and distal ornamentation varies amongst the different groups.

Antennae.– Antenna 1 is sexually dimorphic, with the flagellum longer in males than in females. The first article is the largest and setation varies between species. Antenna 2 is rarely found to be complete, often breaking off after the fourth article. Articles 1–4 are short and the general shape of articles 2–4 are uniform throughout the family. The shape of article 1 varies between subfamilies, as a prominent spine is present on the lateral margin in some genera (for example, *Notopais*, Hodgson, 1910 and *Storthyngurella* Malyutina 1999b) to this margin being straight and having no spine. One thing that varies amongst the different subfamilies is the presence on an antennal scale, while in Storthyngurinae, the scale is present but somewhat fused.

Mouthparts.– Of all the mouthparts, it is the mandible that varies the most not only between subfamilies, but it can vary within a subfamily. The palp is both present and absent in the Munnopsidae and the shape of the last article can be characteristic of some groups. The incisor can be either dentate or massive, rounded and not dentate. The lacinia mobilis and the spine row are both either present or absent in the Munnopsidae, while the mandibular molar varies in size.

Maxilla 1 and maxilla 2 are remarkably uniform in shape throughout the group. Maxilla 1 consists of a larger lateral endite and a smaller mesial endite. Maxilla 2 consists of three endites, the lateral and middle endites being of similar size while the mesial endite is larger.

The maxilliped is uniform, the Syneurycopinae being the only subfamily that lacks coupling hooks. Differences also lie in the shape of the palp and the epipod. The palp has five articles and generally articles 4 and 5 are the smallest. The epipod can be either oval or elongate with a distal narrow tip and can have a lateral projection.

Pereopods.– Pereopods are of two forms: the ambulatory anterior four and the natatory posterior three. Pereopods 3 and 4 are typically the longest, except in *Pseudarachna* where pereopod 2 is longest. The natatory pereopods have a flattened and expanded carpus and propodus which are fringed with long plumose setae (natatory setae). The degree of expansion of the carpus and propodus however, is largely dependent on the swimming ability of the genus. In *Microprotus* Richardson, 1910, and in some species of *Storthyngurella* and

Storthyngura Vanhöffen, 1914 the natatory pereopods have reversed to being tubular and lacking natatory setae.

Pleopods.– Females have four pairs of pleopods (pleopod 1 is absent), while males have five. In females, pleopod 2 is fused into one appendage, and is typically referred to as an operculum. The operculum is boat shaped, can have a medial keel running down the centre and has elongate setae down the lateral margins. Male pleopods 1 are fused into a single unit, are elongate and narrow and have the same basic shape throughout the family. Pleopods 2 are typically not fused (except in the Munnopsinae) and their shape can vary from being triangular to semi-oval. The position of the stylet and exopod vary along the mesial margin between different groups as can the size and shape of the stylet. The shapes of pleopods 3–5 are similar within the family. Most typically, the differences lie in the length of the exopod relative to the endopod in pleopods 3 and 4 and in the number of plumose setae on the endopod and exopod. Setal numbers can differ at a species level. Pleopod 5 is a simple lobe.

Uropods.– The uropods are either lamellar and flat (for example in the Ilyarachninae) or are tubular (for example in the Storthyngurinae) and can come in a range of sizes, even within a subfamily. Uropods are generally either uniramous or biramous, however some species of *Lipomera* Tattersall, 1905a lack rami altogether.

1.3 Introduction of the subfamily Ilyarachninae

Within the Munnopsidae, the Ilyarachninae is one of the larger subfamilies. The first ilyarachnine species was described by Georg Ossian Sars (son of Michael, who described the first munnopsid) who had collected specimens from the Christiania Fjord in Norway. He established the genus *Mesostenus* Sars, 1864 for *Mesostenus longicornis* Sars, 1864, at that time placing it in the family Munnopsidae. The name *Mesostenus* was preoccupied and Sars transferred the species to *Ilyarachna* Sars, 1870. Sars described a further four species from Norwegian waters: *Ilyarachna hirticeps* Sars, 1870; *Ilyarachna hirsuta* Sars, 1864; *Ilyarachna coronata* Sars, 1870; and *Ilyarachna clypeata* Sars, 1870. In 1897, Sars established three new genera to accommodate

what he considered distinct differences in three of the Norwegian species. These new genera were: *Aspidarachna* Sars, 1897b for *I. clypeata*, *Echinozone* Sars, 1897b for *I. coronata* and *Pseudarachna* Sars, 1897b for *I. hirsuta*, genera which are still accepted today.

Notopais Hodgson, 1910 was erected for the single female specimen of *Notopais spicatus* Hodgson, 1910 from Antarctica and was placed in the family Munnopsidae. Four years later the monotypic *Notopais* was synonymised with *Pseudarachna* by Vanhöffen (1914). As part of this present study, *Notopais* was brought out of synonymy and revised in 2004 (see Merrin 2004b).

Hansen (1916) transferred *Aspidarachna*, *Echinozone*, *Ilyarachna* and *Pseudarachna* from Munnopsidae to Ilyarachnidae Hansen, 1916. Hult (1937) synonymised the genera *Echinozone* and *Aspidarachna* with *Ilyarachna*. Wolff (1962) and Menzies (1962) considered all ilyarachnid species except *P. hirsuta* to belong to *Ilyarachna*.

Hessler and Thistle (1975) reassessed the species of the then Ilyarachnidae, reinstating the four genera of Sars and reallocating several species. They established a new genus, *Bathybadistes* Hessler and Thistle, 1975 for the deep-sea species, *Bathybadistes hoplitis* Hessler and Thistle, 1975 and included eight species that had previously been assigned to *Ilyarachna*, seven names of which are still valid (*Ilyarachna argentinae* Menzies, 1962 was synonymised with *Ilyarachna multispinosa* Menzies, 1962 by Wolff 1962, p. 97). They did, however, have reservations on their placement of three species (although they did not discuss why), these being *Ilyarachna scabra* Birstein, 1971, *Ilyarachna tuberculata* Birstein, 1971 and *Ilyarachna venusta* Birstein, 1971.

In his review of the Munnopsidae, Kussakin (2003) revised the Ilyarachninae, retaining Sars' genera but splitting *Bathybadistes* (in part) between *Ilyarachna* and *Echinozone*.

Morphologically, the Ilyarachninae follow the munnopsid plan, although many genera have their own specific variations (see Chapter 3 for further discussion). In general however, the Ilyarachninae are defined by: a broad and flat frontal arch; a calcareous mandible with an incisor process with no defined

cusps; pereonites 3 and 4 bases short, their length near width; and their small flattened leaf-like uropods.

Prior to this study, the subfamily Ilyarachninae consisted of the genera, *Aspidarachna*, *Bathybadistes*, *Echinozone*, *Ilyarachna* and *Pseudarachna*, and included 56 species.

1.4 Aims

This study was intended to be primarily taxonomic, with the subject subfamily the Ilyarachninae, beacuse there were few records from around New Zealand and south-eastern Australia, but was prevalent on museum shelves (primarily NIWA, the Australian Museum and Museum Victoria).

With the large number of new species from this region described, it was decided to see how these species related to the rest of the subfamily worldwide – a quest which was developed into the title and thus one of the main themes of this thesis.

The relationships, both generic and at species level, were elucidated by performing several cladistic analyses. These analyses not only considered the relationships between species, but it also served to test the hypothesis that the genera of the Ilyarachninae are monophyletic. The genera, created by classical taxonomists based on morphological characters, have never had their monophyly tested by phylogenetic means.

The methods used in the analyses (Chapter 3) were chosen to use real species as an outgroup and not use an inferred outgroup or hypothetical ancestor. In previous phylogenetic studies of the family Munnopsidae Wilson (1989) and Wägele (1989) both found the Ilyarachninae (or just the *Ilyarachna* in the case of Wilson (1989)) to be part of larger polytomies with no clear indication of which group was the likely sister group to the Ilyarachninae. A second phylogenetic analysis, this time of the family Munnopsidae was conducted to resolve this and identify a suitable outgroup for the analysis of the subfamily (Chapter 2).

The family-level analysis aimed to not only to find an outgroup of the Ilyarachninae, but it subsequently also tested the monophyly of the subfamilies

and sort to resolve the placement of the three genera which are still currently *incertae sedis*.

This thesis is written in reverse order in which the ideas in reality came about, as it is more sequential, with the conclusions from each chapter influencing the next. Each chapter has been written as a separate entity and in due course they will be published as separate papers.

Chapter 2: A phylogenetic revision of the family Munnopsidae

Relationships within the Munnopsidae have been presented by several workers (see Wolff 1962; Kussakin 1973; Hessler and Thistle 1975; Wilson and Hessler 1981; Wilson 1982; Wilson and Thistle 1985; Wägele 1989; Wilson 1989), with Wägele (1989) and Wilson (1989) exploring the relationships by phylogenetic means. Neither analysis however, gave a clear indication of which group of animals are the sister group to the Ilyarachninae and thus could be used as an outgroup for analysis at subfamily level. Therefore a reanalysis of the family Munnopsidae was conducted, an analysis, which subsequently tested the monophyly of the existing subfamilies and attempted to resolve the placement of the previously unplaced genera: *Munnopsurus*; *Munneurycope* and *Munnicope*.

2.1 Phylogenetic review

2.1.1 A summary of past methods used in constructing asellote phylogenies

Past methods used to construct asellote phylogenies were in two areas, those which used non-computer methods and those which used computer assisted cladistics (CAC).

The use of CAC methods versus non-computer methods in reconstructing isopod phylogenies received prominence in the literature in the 1990s by either one of two parties, where each were championing their own cause over the other (see Wägele 1989; Brusca and Wilson 1991; Wilson 1992; Wägele 1994; Wägele *et al.* 1995; Wägele 1996; Wilson 1996a; Wilson 1996b).

Central to the non-computer methods of reconstructing phylogenies is the concept of identifying a taxon's groundpattern. Wilson (1996b, p. 140, italics in original) defined a groundpattern of a taxon as "an assemblage of presumed *ad hoc*, *a priori* ancestral character states." The determination of the groundpattern for a taxon relies on assessing the phylogenetic information outside the analysis

and then deducing the ancestral states (Yeates 1995; Wilson 1996b). Depending on the criterion followed, the determination of the groundpattern can result in different conclusions on which character states are considered to be plesiomorphic, as pointed out by Jenner and Schram (1999). Trees obtained by groundpattern analysis are considered by some to be unscientific, as this method does not test the proposed hypothesis, and also unparsimonious, as the characters used are not globally optimised (Wilson 1996b).

Two examples of asellote phylogenies which use non-computer methods were those of Kussakin (1973) and Wägele (1989). Kussakin (1973) did not explain his method of tree construction, while Wägele (1989) used groundpattern analysis to not only construct relationships within the Asellota, but also to analyse the entire Isopoda.

Unlike groundpattern analysis, CAC methods produce testable hypotheses of relationships between taxa. These methods compute the often huge number of permutations that would be impossible to do by hand (Wilson 1992), as the number of possible trees increases as a polynomial function of the number of taxa (Felsenstein 1978).

One of the earliest users of CAC for the Isopoda was Wilson (1989) who used several different computer programs to analyse the Munnopsidae. Wilson (1989) used a branch and bound search algorithm, an exact method which is only suitable for small datasets (Kitching *et al*. 1998). More recently, heuristic search algorithms have dominated morphological cladistic analyses of the Isopoda (for example, see Poore 2001; Brandt and Poore 2003; Just and Wilson 2004). These methods are suitable for large datasets but sacrifice the guarantee of optimality for a reduction in computing time (Kitching *et al*. 1998). The use of molecular data for CAC analysis of isopods to infer relationships have used a variety of methods including maximum parsimony, maximum-likelihood and Bayesian approaches (for example, see Held 2000; Wetzer 2002; Wägele *et al*. 2003; Raupach *et al*. 2004).

2.1.2 Phylogenetic review of the Munnopsidae

The two previous phylogenetic analyses of the Munnopsidae were by Wilson (1989) and Wägele (1989). Wilson (1989) based his analysis on CAC and used 19 representative genera (from a possible total of 32), an outgroup (Acanthaspidiidae) and 26 morphological characters. Wilson (1989) included all genera for two subfamilies (although then, previous to his conclusions the groups were considered to be families) with the Eurycopinae and the Lipomerinae and subsequently only tested the monophyly of these two groups. The other subfamilies only had one representative genus included and he thus assumed monophyly of these groups in his conclusions. Wägele (1989) used 37 morphological characters to analyse 31 genera in his groundpattern analysis (see Fig 2.1).

Although Wagele's (1989) cladogram has somewhat more structure than Wilson's (1989), both studies conclude that the Eurycopinae is the most ancestral subfamily in the Munnopsidae. There are several differences between the results of these two analyses. The Munnopsinae is the sister group to *Munnopsurus* in Wägele's (1989) analysis while in Wilson's (1989) analysis both these subfamilies representatives are in a large unresolved polytomy with several other genera. The position of the Syneurcopinae is also different between the two analyses. In Wilson's (1989) analysis *Bellibos* Haugness and Hessler, 1979 (representing the Syneurycopinae) is in the same unresolved polytomy as previously mentioned, while in Wägele's (1989) analysis the Syneurycopinae are the sister group to a clade containing *Acanthocope* Beddard 1885 (the only genus in the Acanthocopinae), *Microprotus* Richardson, 1910 and *Storthyngura* Vanhöffen, 1914.

Neither study, however, gives an indication of a possible sister group to the Ilyarachninae as in both analyses, this subfamily is part of a larger polytomy. In Wilson's analysis, *Ilyarachna* is in a polytomy with *Amuletta* Wilson and Thistle, 1985, *Betamorpha* Hessler and Thistle, 1975 and *Storthyngura*, while in Wägele's (1989) analysis the Ilyarachninae form a polytomy with several mixed subfamily clades: a *Munnopsurus*-Munnopisnae clade; a Synerycopinae–

Acanthocopinae–*Storthyngura–Microprotus* Richardson, 1910a clade; and a *Betamorpha–Amuletta* clade.

The following analysis sets out to resolve this quandary by incorporating 122 morphological characters and species representing all 37 genera. The use of actual species in this study instead of, for example, conducting the analysis using just genera as terminals, is to avoid making assumptions about character states. Constructing groundplans for genera does involve making assumptions about which character states are pleisiomorphic. There is also the problem of polymorphism in genera, where there are examples of species within the same genus showing conflicting states of the same character. Making assumptions on how to code such characters, for example using the commonality approach (see Brandt and Poore 2003 for an example), could lead to spurious relationships and would not necessarily result in the most or accurate representation of character transformation within the family.

In addition, this analysis will also test the monophyly of the nine subfamilies of the Munnopsidae (two of which have been established since 1989: Betamorphinae and Storthyngurinae) and will also sort to resolve the placement of the three previously unplaced genera: *Munnopsurus*, *Munneurycope* and *Munnicope*.

2.2 Methods

2.2.1 Taxa included

Ingroup

At least one representative, usually the type species, was selected from each genus, with additional species selected where possible (see Appendix 2.1). As this analysis is based largely on data obtained from the literature, some inadequately described type species were not included, and were substituted with well-illustrated congeners. The ingroup consisted of 72 species representing all 37 munnopsid genera. Appendix 2.1 lists the species and references used.

Outgroup

The morphological similarities between the family Desmosomatidae and Munnopsidae have been commented on by several authors, for example, Wägele (1989) and Hessler (1970). Hessler (1970) concluded that although desmosomatids were possibly "primitive natatory asellotes" (page 21), they were not that closely related to other such groups and were more related to the Nannoniscidae Hansen, 1916 and the then Pseudomesidae Hansen, 1916 (now synonymised with Desmosomatidae, see Svavarsson 1984).

A recent phylogenetic study based on molecular data of several deep-sea asellote families has found that the desmosomatids are the sister group to the munnopsids and are a part of what was termed the 'munnopsoid radiation' (Raupach *et al.* 2004). Based on this data, two species of desmosomatids, *Desmosoma hesslera* Brandt, 1992a (this name is incorrectly constructed and will be referred to in this thesis as *hessleri*) and *Eugerda gigantea* Park, 1999 were selected as the outgroup.

2.2.2 Character discussion

In the analysis of the family Munnopsidae, 122 morphological characters were used. All were unordered and unweighted, with 88 characters being binary and 34 characters with three or more states. Characters are discussed in detail below and are listed with states and respective figures in Appendix 2.2.

Body and cephalon

The presence of a natasome (character 1) is one of three synapomorphic characters determined by Wilson (1989) in his definition of the Munnopsidae.

The munnopsid cephalon displays a wide range of potentially useful morphological characters, some of which have been used to define genera. Several genera in the Eurycopinae exhibit an anterior projection of the cephalon vertex (character 2, Fig. 2.2A). Such an extension has previously been termed a rostrum (for example see Wilson and Hessler 1980; Wilson and Hessler 1981; Wilson 1989), but it is difficult to conclude whether the broad but short extension seen in a species such as *Tytthocope megalura* (Sars, 1872) is

homologous to a rostrum found in many decapods. For this reason, the term rostrum is not used in this analysis.

The usefulness of the presence of a frontal arch (character 3) was first discussed as a subfamily defining character by Wilson (1989). While the majority of munnopsids possess a frontal arch, its absence is a synapomorphy of the Eurycopinae (Fig. 2.2A). An incipient frontal arch (as defined by Wilson 1989) is a character state of the Munnopsinae (Fig. 2.2B), while a flattened frons and reduced arch is found in several Lipomerinae genera (Fig. 2.2E; Wilson 1989). Where a frontal arch is present, the shape can differ between subfamilies. A potentially defining character for the Ilyarachninae is a broad, flat frontal arch (character 4; Fig. 2.2D), while in the Storthyngurinae, the frontal arch is a narrow inverted 'V' (Fig. 2.2F). Within the Ilyarachninae, the frontal arch meets the maxillipeds at two different angles (character 5).

The clypeus shows different degrees of being arched (character 6). It is not arched in the Munnopsinae, *Munneurycope* or *Munnicope* (Fig. 2.2B), while species of Ilyarachninae display a small, central arch (Fig. 2.2D). Many genera display a low, wide arch, while several Eurycopinae and Lipomerinae genera share the character state of a clypeus with a high arch (Figs 2.2A, C and D).

The outgroup and the majority of the munnopsids have a relatively oblong cephalon that is not widest posteriorly (character 7). This differs from the Ilyarachninae, which display a distinct trapezoid shaped cephalon which is widest posteriorly. Such a widening enables the cephalon to accommodate their enlarged, specialized mandibles and the surrounding musculature.

Spines on the cephalon and body can be considered to be homoplasious and have appeared independently many times within the asellotes (Wolff 1962). The presence of spines on the cephalon (character 8) and body (characters 14–16, 18, 29, 30 and 32) also appear in many munnopsid genera across the subfamilies. Although spines are used to define genera, the phylogenetic significance of these characters have not been tested.

Syneurycope Hansen, 1916 is the only genus which has the cephalon fused to pereonite 1 (character 9).

In *Disconectes* Wilson and Hessler, 1981, pereonites 1–4 ventrally bulge lower than the anterior part of pereonites 5–7 (character 10; Fig. 2.2G).

Many species of the Munnopsinae have pereonites 1–4 much wider than pereonites 5–7 (character 11; Fig. 2.2H). A reduced pereonite 1 (character 12; Figs 2.2H and I) can be seen in several munnopsid genera and is found in the closely related Munnopsinae genera of *Munnopsis* Sars, 1861 and *Pseudomunnopsis* Hansen, 1916, and has probably arisen independently in *Paropsurus* Wolff, 1962. A reduced pereonite 1 also appears in the outgroup. Pereonites 5–7 more than twice as long as pereonites 1–4 is a character state of the Bathyopsurinae Wolff, 1962 and is also found in *Aspidarachna* and several species within the Lipomerinae and Eurycopinae.

The anterolateral angles of pereonites 3 and 4 may be indented, forming a lobe or lateral spine-like extension (characters 17 and 19; Fig. 2.2J). These lobes or spines are present in many munnopsid species.

A large and considerably swollen natasome is the defining synapomorphy for the subfamily Bathyopsurine (character 20; Fig. 2.2I). When revising *Eurycope*, Wilson and Hessler (1981) considered a ventrally enlarged pereonite 5 a diagnostic apomorphy for *Belonectes* Wilson and Hessler, 1981 while a ventrally enlarged pereonite 6 was a diagnostic apomorphy for *Tytthocope* Wilson and Hessler, 1981 (character 21; Fig. 2.2K).

In the natasomal pereonites of the Munnopsidae, the presence or absence of dorsal sutures and fusion between different pereonites (characters 22 and 23) can be used to define both genera and subfamilies. For example, all Storthyngurinae have an immovably fused natasome, but *Vanhoeffenura* and *Rectisura* have sutures present, while all Ilyarachninae have a free and articulating natasome.

Narrowing lateral margins of pereonites 5–7, where the margins are distinct from each other (character 24; Figs 2.2J and 2.3A), have developed independently at least three times in the Munnopsidae. It is found in Acanthocopinae, most Storthyngurinae, *Bathybadistes*, some *Echinozone* species, *Munnicope* and *Eurycope magna* Birstein, 1963. Narrow lateral extensions of pereonites 5–7 (character 25; Fig. 2.2J) are an apomorphy for

Bathybadistes, *Acanthocope*, *Acanthamunnopsis* Schultz, 1978 and are found in most species of Storthyngurinae.

Pereonite 5, being much larger than pereonite 6 (character 26; Fig. 2.3B), is found in the Lipomerinae and occurs in several other unrelated munnopsid species as well as in the outgroup. In many species, pereonite 5 is the widest pereonite (character 27). Pereonite 5 with an anteriorly narrowing and elongating 'neck' is a defining character of the four north-western Pacific ilyarachnine species described by Birstein (1963; Fig 2.3A).

One of the characters Wilson (1989) used in his definition of the Lipomerinae was a reduced or absent pereonite 7 (character 31; Fig. 2.3B), a state which also occurs in the Eurycopinae genus *Tytthocope*.

The presence of apical setae on tubercles or spines (character 33) is an apomorphic state found in several different genera as a result of convergence.

The absence of a dorsal suture between the pleon and the rest of the body (character 34) is an apomorphic character found in the Acanthocopinae Wolff, 1962, *Acanthamunnopsis*, *Microprotus* Richardson, 1910 and in *Storthygurella hirsuta* Malyutina, 1999b.

Antennae

Within the munnopsids it is common to find antenna 1 to be positioned not directly posterior to antenna 2, but more towards the centre or on the inner side of these antenna (character 35).

Antenna 1 article 1 broadened, with a flattened lateral flange and medially thickened is one of three synapomorphies defined for the Munnopsidae by Wilson (1989), although it is more sub-cylindrical in the Syneurycopinae (Fig. 2.3C). Article 1 is generally known to have rounded margins, although it can either have a spine-like projection (character 37; Figs 2.3E and F) or a serrate lateral margin (character 38; Fig. 2.3D). Distally article 1 can either be bilobed, have 1 lobe or no distal lobe (character 39; Figs 2.3F, G and H).

The insertion of article 2 laterally on article 1 in antenna 1 (character 40; Fig. 2.3I) is found in several Munnopsinae genera and could be useful in considering the relationships between them. Article 2 can either be shorter or

longer than the longest lobe on article 1 (character 41) and can have either a distal lobe (character 42; Fig. 2.3F) and/or a proximal process (character 43; Fig. 2.3J).

Article 3 of antenna 1 being longer than article 1 (character 44) appears to be homoplasious within the Munnopsidae.

A spine on the first article of antenna 2 (character 45) can be found in two munnopsid subfamilies, the Ilyarachninae and Storthyngurinae. Their shape (character 46) is a diagnostic character for some genera, for example, the prominent 'horn-like' spine found in *Notopais* (Fig. 2.4B). Spines can also be present on antenna articles 2 and 3 (characters 47 and 49, respectively).

A present, but partly fused antennal scale on antenna 2 is a diagnostic character of the Storthyngurinae (Malyutina 2003a; Malyutina 2003b), while the absence of an antennal scale is found in several subfamilies as well as in the outgroup (character 48).

Mouthparts

The mandible of the Ilyarachninae, Munnopsinae and of *Munnopsurus* is highly modified in comparison to the plesiomorphic state and is thought to be independently derived (Wilson 1989). These groups have an enlarged and rounded incisor process with the cusps either absent or weakly defined (character 50; Fig. 2.4C). Some species within these groups have lost the lacinia mobilis (character 51), although, when present, it can be highly reduced (character 52). The mandibular spine row has also been lost in several species within these three groups (character 53).

A reduced or absent mandibular molar (character 54) is an apomorphic character found in several closely related Munnopsinae genera and in the Bathyopsurinae.

A broad and truncate mandibular molar is the primitive janiroidean condition (Wilson and Thistle 1985) (character 55; Fig. 2.3C).

The mandibular palp has been lost in several genera in the Munnopsidae (character 56) and, when present, can either be slender or robust (character 57; Figs 2.4D, E and H). When present, the palp reaches past the distal end of the

mandible in all but a few species (character 58). The shape of the third mandibular palp article (character 59; Figs 2.4D–H) and the presence or absence of prominent terminal setae (character 60) should be useful in establishing relationships between genera.

The absence of coupling hooks on the maxilliped (character 61; Fig. 2.4J) and the presence of denticles on maxilliped palp article 3 (character 62; Fig. 2.4J) are two diagnostic characters which Haugsness and Hessler (1979) used to define the Syneurycopinae.

The majority of munnopsids have a distal projection on the mesial margin of the maxilliped palp article 4 (character 63; Fig. 2.4I) and this article is larger than article 5 (character 64).

The size and shape of the maxilliped epipod (characters 65–67; Figs 2.4I, J and 2.5A, B) should provide useful information about the relationships between munnopsid genera.

Pereopods

A synapomorphy defined by Wilson (1989) for the Munnopsidae is the trough-like dactylar claw of pereopods, which encloses the sensillae (character 68).

Pereopod 1 is usually slender (character 69; Fig. 2.5C) and the inferior margin of the carpus shows two setation patterns. The setae are either spread evenly along the length of the margin or are more predominant in the proximal half of the article (character 71; Figs 2.5C and D).

Basis length of respective pereopods in relation to other basis lengths (characters 70, 72, 77 and 81) have been useful in defining both subfamilies and genera and such characters were used by Wilson (1989).

The third synapomorphy defined by Wilson (1989) for the Munnopsidae is that pereopods 5–7 are natatory, whereby the carpus and propodus are somewhat flattened and expanded, and are fringed with long plumose marginal setae. In Wilson's (1989) analysis, these two states were combined as one character state, however, in this present analysis these states are considered separate characters. The first character is defined as to whether the articles are

flattened or not (character 73) and the second indicates the presence or absence of plumose marginal setae (character 74).

If natatory, the proximal region of the carpus superior margin of pereopods 5 and 6 can project beyond the distal margin of the merus (characters 75 and 76; Fig. 2.5E).

In the Munnopsinae, Acanthocopinae and some species of Storthyngurinae, the ischium superior margin of pereopods 5–7 lack natatory setae (character 78). Within the Munnopsinae, there is variation in the arrangement of plumose setae on the propodus inferior margin (character 79; Fig. 2.5F).

Pereopod 5 inserted dorsally higher than pereopods 6 and 7 (character 80) is a distinguishing character of the Bathyopsurinae and has evolved independently in the genus *Acanthamunnopsis*.

Within the Lipomerinae, pereopod 5 merus can be far more elongate than in other munnopsid subfamilies (character 82). Its length in relation to basis length was used by Wilson (1989) as a defining character of *Mimocopelates* Wilson, 1989.

The degree of expansion of the carpus in relation to propodus width (characters 83 and 84) should be useful in determining relationships between species.

Wilson (1989) considered a rudimentary or absent dactylus in pereopods 5–7 as the same character state. For this analysis, the dactyli of pereopods 5–7 were treated independently and a rudimentary dactylus is considered to be a distinct state to that of being absent (characters 85, 86 and 88).

The size of pereopod 7 in relation to pereopod 6 is a useful character in defining certain taxa (character 87). A small pereopod 7 in relation to pereopod 6 with narrow carpi and propodi is characteristic of the Ilyarachninae and is also found in some Lipomerinae genera. A rudimentary or absent pereopod 7 is characteristic of *Mimocopelates* and *Lipomera* Tattersall, 1905a.

Pleonites and Pleotelson

A wide pleonite 1 which is equal to the width of the anterior margin of the pleon (character 89; Fig. 2.2I) is characteristic of the Bathyopsurinae.

The size, shape and ornamentation of the pleotelson are useful characters and can be defining at both generic and subfamily level (characters 90–95). A pleotelson with an anterolateral spine and apical seta (character 90; Fig. 2.2J) and lateral extensions (character 91; Figs 2.5G and H) are distinguishing characters of the genus *Bathybadistes*, while the latter is also found in the Acanthocopinae and many species of the Storthyngurinae. The pleotelson can be ornamented dorsally with tubercles and/or spines (character 92) and can have a projection distally (character 93). The shape of this projection (character 94, Figs 2.5G–I) has been used in defining genera of the Storthyngurinae by Malyutina (2003a; 2003b).

Pleopods

In the Munnopsidae, the female operculum usually has a medial keel (character 96) which can be ornamented with setae (character 98). In *Acanthocope* and some Storthyngurinae, the operculum also has a spine (character 97; Fig. 2.5J).

A synapomorphy for *Acanthocope* is the distinctive size of the first male pleopod which is less than half the length of pleopod 2 and, *in situ*, sits at the proximal end of the medial junction of pleopods 2 (character 99).

In male pleopod 1, the distal lobes can be at an acute angle to each other and are widely parted (character 100; Fig. 2.6A). The relative length of the outer rami in reference to the inner rami of male pleopod 1 (character 101) should have some bearing on the relationships within the family.

Male pleopod 2 is widest proximally (character 102) in many species of Lipomerinae, with the fusion of these pleopods (character 103; Fig. 2.6B) a synapomorphy of the Munnopsinae.

A distinguishing character of the *Acanthocope* is the exopod and stylet of male pleopod 2 positioned on the proximal margin of the protopod instead of on

the mesial margin (characters 104 and 106). These two appendages can also vary in size and shape (characters 105, 107, 108).

Wilson (1989) stated that three plumose setae on the endopod of pleopod 3 is a reversion to the plesiomorphic janiroidean state, although within the Munnopsidae, it was considered to be apomorphic, as the Acanthaspidiidae (used as the outgroup in his analysis) have numerous plumose setae on the endopod. The Desmosomatidae, the outgroup used in the present analysis, exhibits the plesiomorphic janiroidean state of three plumose setae on the endopod, and thus this state in the Munnopsidae cannot be considered as being apomorphic for this family (character 109).

A character for the outgroup is a reduced and small exopod of pleopod 3 (character 110), while in the munnopsids, the exopod is elongate and can extend past the endopod. The exopod can have none or many plumose setae (character 111) and can be of either 1 or 2 articles (character 112). An abrupt change in width between articles 1 and 2 of the exopod (character 113; Fig. 2.6C) was used by Malyutina (2003a; 2003b) to define *Vanhoeffenura*. The same state has evolved independently in *Belonectes parvus* (Bonnier, 1896).

The exopod of pleopod 4 can have between none and many plumose setae (character 114) and can be wider than half the width of the endopod (character 115).

Uropods

Biramous uropods is the plesiomorphic state. Some munnopsids have only one uropodal rami and in *Lipomera*, both rami are absent (character 116). A flattened, leaf-like uropodal protopod (character 117; Fig. 2.6D) is a synapomorphy of the Syneurycopinae, several Lipomerinae genera and the Ilyarachninae. When tubular, the protopod length can vary (character 118), from being small and unable to be seen in dorsal view in genera such as *Eurycope*, to being elongate and prominent in dorsal view as seen in *Storthyngura*.

Uropodal rami are usually inserted distally on the protopod (character 119), and are positioned distolaterally on the Ilyarachninae, *Amuletta* and many Syneurycopinae. A diagnostic character for *Betamorpha* is that the rami are

located proximally on the protopod. Sub-equal rami (character 120) have appeared independently three times in the munnopsids and the endopod has, in some cases, become longer than the protopod (character 121). A tiny or rudimentary uropodal exopod (character 122; Fig. 2.6D) is a synapomorphy for the *Bathybadistes* and also occurs in species of *Ilyarachna*, *Paramunnopsis* Hansen, 1916, *Mimocopelates* and *Munneurycope*.

2.2.3 Cladistic analysis

A data matrix was constructed in DELTA (Dallwitz *et al*. 1997) (see Table 2.1) and a nexus file was generated for input into PAUP* 4.0b10 (beta-test version for Windows; Swofford 2001). The data was, as mentioned, treated as unordered and unweighted for the first analysis.

A heuristic search method was used (PAUP instructions in brackets), with tree-bisection-and-reconnection (TBR) branch swapping. The search was conducted with 1000 random addition sequence repetitions (NREPS=1000; ADDSEQ=RANDOM), where no more than 5 trees, of 1 step greater or equal to the minimum length tree at each iteration were saved (NCHUCK=5; CHUCKSCORE=1). The initial starting tree at each iteration was selected at random (RANDOMIZE=TREES). All trees were rooted with the outgroup, which was considered a monophyletic sister group to the ingroup (OUTROOT=MONOPHYL). The topology of the saved trees were summarised with a strict consensus tree (Sokal and Rohlf 1981) and a 50% majority-rule consensus tree (Margush and McMorris 1981) (not figured).

A second analysis, using successively weighted characters was also conducted to see if the resolution could be improved. This was accomplished using the reweight option in PAUP, where the characters were reweighted by their rescaled consistency index. This was completed after three reweighting runs, each time using the same heuristic search methods mentioned above after which, the character weights did not change. After the final run, the trees were saved and their topology summarised with a strict consensus tree (Sokal and Rohlf 1981).

A bootstrap analysis (Felsenstein 1985) was performed on both topologies using the same heuristic search constraints as mentioned above and was based on 100 pseudoreplicates. All trees were illustrated using TreeView 1.6.6 (© Roderic D. M. Page, 2001).

Some characters, for example, dorsal body spines, can be homoplasious, and such characters can lead to misinterpretations of relationships. These characters were removed from the character matrix (characters 8, 14, 15, 16, 18, 29, 30, 32; character 22 was also removed as visible sutures can also be homoplastic) and this revised dataset is referred to in the text as the modified dataset (that is, it is the original dataset with these characters removed). A third analysis was run under the same search constraints as mentioned above using the modified dataset with unweighted characters (analysis 3); and a fourth analysis using the modified dataset with successfully weighted characters (analysis 4). Characters were reweighted using the same reweighting methods as mentioned above. These analyses were run to see if the presence or absence of spines and sutures influence tree topology. A bootstrap analysis was not conducted.

2.3 Results

2.3.1 Analysis of the Munnopsidae with discussion of clades

The first analysis, using unweighted characters, found 2000 most parsimonious trees of tree length of 613, with a consistency index (CI) of 0.27 and a retention index (RI) of 0.73. One character, character 21, was considered parsimony uninformative. Successive weighting of the characters improved the resolution in the strict consensus tree (see Fig. 2.7 compared to Fig. 2.8) and resulted in nine most parsimonious trees with an increased CI of 0.5 and a RI of 0.81. Reweighting the characters lead to five being given a weight of 0, 54 were given a weight of less than 0.2, 40 were given a weight between 0.2 and 1 and 23 characters were given a weight of 1 (see Table 2.2).

Analysis 3 found 755 most parsimonious trees of tree length of 542, with a CI of 0.27 and a RI of 0.72. Successive weighting of the characters (analysis 4) also improved the resolution of the strict consensus tree (see Fig. 2.9 compared

to Fig. 2.10) and found three most parsimonious trees with an improved CI of 0.52 and a RI of 0.87. One character was also considered parsimony uninformative (also character 21). Reweighting the characters lead to 3 being given the weight of 0, 50 characters were given a weight of less than 0.2, 38 characters were given a weight between 0.2 and 1 and 22 characters were given the weight of 1 (see Table 2.2).

In all analyses, the subfamily Munnopsinae is the most basal. Comparing the first two analyses, both using the full dataset, analysis 1 has four major clades, while analysis 2 has three. The composition of some clades in analysis 2 differ from those seen in the first. Analysis 1 supports the monophyly of all subfamilies, except the Betamorphinae. In analysis 2, the monophyly of the Betamorphinae is supported, but with the inclusion of *E. magna* and *Munnicope calyptra* Menzies and George, 1972.

In analysis 2, the Syneurycopinae is the sister group to the Acanthocopinae–Storthyngurinae clade, while in analysis 1, this subfamily is one of the main clades in a four-clade polytomy.

In analysis 1, the relationships of the three unplaced previously genera is somewhat resolved. *Munnopsurus* is the sister group to the Ilyarachninae, while *Munneurycope* is in a large polytomy with *Amuletta abyssorum* (Richardson, 1911), the Ilyarachninae–*Munnopsurus*–Betamorphinae clade, the Eurycopinae–Lipomerinae clade and the Bathyopsurinae. *M. calyptra* together with *E. magna* is the sister group to this larger clade. In analysis 2, the placement of these genera differ. Together, *M. calyptra* and *E. magna* is the sister group of the Betamorphinae. *Munnopsurus laevis* (Richardson, 1910) is the sister species to the Ilyarachninae, while *Munnopsurus giganteus* (Sars, 1879) is the sister species to the *Munneurycope*. This latter clade forms a polytomy with the Ilyarachninae–*M. laevis* clade and the Eurycopinae–Lipomerinae clade.

Both analyses 3 and 4, using the modified dataset, look more similar to the topology of analysis 1 than that of analysis 2. Both analyses 3 and 4 support three major clades. Betamorphinae is not supported in either analysis, while in analysis 3, the Eurycopinae are not monophyletic. Of the three genera previously unplaced in a subfamily, the placement of *Munnopsurus*, *Munneurycope* and

Munnicope in analysis 3 is the same as the results found in analysis 1. In analysis 4, *Munneurycope* is the sister group to the Eurycopinae–Lipomerinae clade, with *M. calyptra* and *E. magna* the sister group to this larger clade. In analysis 4, the Bathyopsurinae are the sister group to the Syneurycopinae, while in analysis 3 the Bathyopsurinae is in a polytomy with *Munneurycope*, *A. abyssorum*, the *Betamorpha–Munnopsurus*–Ilyarachninae clade and the Eurycopinae–Lipomerinare clade.

To avoid repetition, only characters defining clades in analyses 1 and 2 are discussed in detail, as the results are similar to those found in analyses 3 and 4. Not all clades are discussed in detail below. Refer to Tables 2.3 and 2.4 for a detailed summary of characters defining clades and terminal species for all analyses. Clades are represented in the text and on the corresponding figures (Figs 2.7–2.15) and tables (Tables 2.3 and 2.4) by numbers or letters. Bootstrap values are mentioned in brackets with the value from analysis 1 referred to first.

Clade 2, the Munnopsinae (93/98; Fig. 2.11) is defined by: mandibular palp article 3 laminar and hooks over; ambulatory pereopod basis 3–4 shorter than basis 2; pereopods 5–7 propodus inferior margin with natatory setae coming down half way of margin pereopods 5–7; pereopod 5 dactylus absent; pereopod 6 dactylus absent; pereopod 7 dactylus absent; male pleopod 2 somewhat fused together; male pleopod 2 stylet article 2 half or more than protopod length; pleopod 3 exopod distal tip with 2 or 3 plumose setae; pleopod 4 exopod more than, or equal, to half endopod width; uropods uniramous; and uropodal exopod tiny or rudimentary. These latter two characters conflict with each other as a character concerning the exopod is inapplicable to all those species which have a uniramous uropod. It is only *Paramunnopsis justi* Svavarsson, 1988 which has a biramous uropod with a tiny exopod. In analysis 1, this clade is also defined by: antenna 2 antennal scale present, not fused; male pleopod 2 stylet filiform; and pleopod 4 exopod with many plumose setae.

Clade 9 (Fig. 2.12; 75/98) contains both the Acanthocopinae and the Storthyngurinae. It is defined by the following characters: pereonite 2 anterior margin with 1 spine; pereonite 3 anterior margin with 1 spine; pereonite 4 anterior margin with 1 spine; pereonites 5–7 lateral margins narrowing, pereonite

margins distinct from each other; pereonites 5–7 with narrow lateral extensions; pereonite 5 wider than rest of body; antenna 2 article 3 with spines; pleotelson (not including anterolateral spine if present) with lateral extensions; distal pleotelson margin with projection; pleopod 3 exopod extending past endopod. In analysis 2 this clade is also defined by: pereonite 4 anterolateral corners indented, forming lobe or sometimes spine-like extension; and uropodal endopod longer than protopod.

The Storthyngurinae and the monogeneric Acanthocopinae are each supported as subfamilies (clade 10; 99/95; and clade 11; 81/98, respectively). The position of the genus *Sursumura* differs between the analyses of the different datasets. This suggests that either dorsal body spines or visible sutures do influence the relationships within the Storthyngurinae.

The third, and largest clade in analyses 1 and 2, is clade 24 (Figs 2.13 and 2.14). It consists of the subfamilies Ilyarachninae, Lipomerinae, Eurycopinae, Bathyopsurinae, the three genera previously unplaced in a subfamily, and the Betamorphinae, although the latter is not a monophyletic group. This clade is defined by: pereopod 5 carpus superior margin proximal region, margin projecting over merus; pereopod 6 carpus superior margin proximal region, margin projecting over merus; pereopod 5 carpus is somewhat expanded, its length is less than twice its width; and pleopod 3 exopod of two articles. This clade in analysis 1 is also defined by: dorsal sutures between pereonites 5–7 present; pereonites 5–7 with narrow lateral extensions absent; and antenna 2 antennal scale present, not fused. In analysis 2 this clade is also defined by: pereopod 5 basis shorter than basis of pereopod 6; and uropod protopod, if tubular and small, can usually just be seen beyond telson in dorsal view. This clade does not exist in analysis 4.

In analyses 1 and 3, a clade with *M. calyptra* and *E. magna* (clade 55; 77 and clade 50, respectively) is the most basal of this larger clade. Together, *M. calyptra* and *E. magna* are the sister group to a large polytomy which includes *A. abyssorum*, *Munneurycope* and the Bathyopsurinae. Clade 26 (clade 27 in analysis 3) *Betamorpha* is the sister group to *Munnopsurus*–Ilyarachninae, and *Munnopsurus* is the sister group to the Ilyarachninae.

In analysis 2, Bathyopsurinae (clade 52) is the most basal group of clade 24 with *M. calyptra* and *E. magna* together as the sister group to *Betamorpha*. In analysis 4, the Bathyopsurinae are the sister group to the Syneurycopinae (clade U). In analyses 1, 3 and 4, the sister group to the Ilyarachninae is the same, however, in analysis 2, only *M. laevis* is the sister species to the Ilyarachninae, with *M. giganteus* the sister species to the *Munneurycope* (clade W).

The Ilyarachninae is well supported with high bootstrap numbers (analyses 1 and 2, clade 30; 95/100) and is supported by the following characters: frontal arch broad and flat; clypeus with small arch just in centre; cephalon trapezoid, wider posteriorly; mandibular molar (if present) triangular, not broad and truncate; ambulatory pereopod bases 3–4 length near width and much shorter than basis 2; pereopod 7 smaller than pereopod 6 with narrow carpi and propodi; uropodal protopod, flattened, leaf-like; and uropodal ramus inserted distolaterally on protopod. In analysis 1, this clade was also supported by: antenna 1 article 1 bilobed; and pereopod 1, carpus, inferior margin with setae more predominant in proximal half, while in analysis 2, this clade is also defined by mandible, lacinia mobilis absent.

Clade 40 (analysis 1 and 2; bootstrap value less than 50, not shown) contains both the Lipomeninae and the Eurycopinae, and is defined by: pereonite 5 wider than rest of body; antenna 1 article 1 bilobed; pereopods 5–7 bases shorter than pereopod 4 basis; if pereopod 5 propodus is somewhat expanded, length less than twice width; and uropod protopod, if tubular reduced, often wider than long, unable to see beyond telson in dorsal view. In analysis 1, this clade is also defined by clypeus with high arch and pleopod 3 exopod distal tip with 2 or 3 plumose setae. In analysis 2, this clade is also defined by: mandibular palp article 3 somewhat curls in on itself laterally; pleopod 3 exopod distal tip with 1 plumose seta; and pleopod 4 exopod with 1 plumose seta.

In both analysis 1 and 2, the Eurycopinae is not supported by high bootstrap numbers (clade 41; less than 50/54), but is monophyletic and defined by: frontal arch absent; pereonite 3 anterolateral corners indented, can form lobe or lateral spine-like extension; male pleopod 2 stylet article 2, half or more than

protopod length; and uropodal endopod longer than protopod. In analysis 1, this clade is also defined by pleopod 3 exopod distal tip with 1 plumose seta.

In analysis 1 and 2, the bootstrap support for the Lipomerinae is higher than that of the Eurycopinae (clade 48; 69/98) and is defined by: pereonite 5 size much larger than pereonite 6; pereonite 7 reduced or absent; antenna 2 antennal scale absent; pereopod 5 merus elongate, but shorter than basis; pereopod 5 dactylus rudimentary; pereopod 7 smaller than pereopod 6 with narrow carpi and propodi; and pleopod 3 of 1 article. In analysis 1, this clade is also characterised by male pleopod 2 widest proximally.

In analyses 3 and 4, the Eurycopinae and the Lipomerinae also align together (clade 39). In analysis 4, *Munneurycope* is the sister group to Eurycopinae–Lipomerinae (clade M) and *E. magna–M. calyptra* is the sister group to this (clade L). In analysis 4, the monophyly of the Eurycopinae is supported, while in analysis 3 it is not and the separate genera form a polytomy with the Lipomerinae, which is monophyletic.

The final main clade of analysis 1 is the Syneurycopinae (clade 56; 97/100; Fig. 2.15). In analysis 2, the Syneurycopinae is the sister group of the Acanthocopinae–Storthyngurinae clade (clade E; 64). The Syneurycopinae are defined by: spines or tubercles with apical setae; antenna 1 article 1 sub-cylindrical; antenna 1 article 1 with no lobe; antenna 1 article 3 longer than article 1; maxilliped without coupling hooks; maxilliped palp article 3 with denticles; maxilliped palp article 4 with no projection on mesial margin; operculum keel with setae; male pleopod 1 outer ramus longer than inner ramus; male pleopod 2 stylet article 2 half or more than protopod length; uropodal protopod flattened somewhat, leaf-like; uropodal ramus inserted distolaterally on protopod. In analysis 1, the Syneurycopinae is also defined by: pereonite 4 anterolateral corners not indented; pleopod 4 exopod with no plumose setae; and uropodal endopod shorter than protopod. In both analysis 1 and 2, all genera are monophyletic, with *Syneurycope* having a higher bootstrap value than *Bellibos* Haugsness and Hessler, 1979 (97/96 versus 65/56).

In analysis 3, the Syneurycopinae (clade 24) is the sister group to the large clade containing Ilyarachninae, Eurycopinae, Lipomerinae, Bathyopsurinae

and the genera previously unplaced in a subfamily (clade 25). In analysis 4, the Syneurycopinae is the sister group to the Bathyopsurinae (clade U).

2.4 Discussion: comparisons — past and present knowledge

The results presented here differ considerably from previous analyses and interpretations. Both Wägele (1989) and Wilson (1989) found that the Eurycopinae were the most basal subfamily of the Munnopsidae, while Kussakin (1973) had earlier considered the Ilyarachninae to be the most basal taxon in relation to the Eurycopinae and Munnopsinae. These results of the present analysis demonstrate that the Munnopsinae is the sister group to all others and not the Eurycopinae.

2.4.1 Munnopsinae

Neither Wägele (1989) nor Wilson (1989) found the Munnopsidae to be the most basal group of the Munnopsidae. In Wilson (1989), the Munnopsinae, represented by *Paramunnopsis*, is in an unresolved polytomy with *Munnopsurus*, *Bellibos*, *Acanthocope*, *Munneurycope*, the Lipomerinae and a clade containing *Betamorpha*, *Storthyngura*, *Ilyarachna* and *Amuletta* (Fig. 2.1A). In Wägele's (1989) study, *Munnopsurus* is the sister group to the Munnopsinae (Fig 2.1B).

This present study is differs to Wilson's (1989), as a different family is used as the outgroup (Desmosomatidae as opposed to Acanthaspidiidae) and several characters have been interpreted differently. Acanthaspidiidae has a 'rostrum', a character state which Wilson scores as present for all Eurycopinae. Wägele (1989) also considered all the Eurycopinae of having a 'rostrum' the presence of such is considered the groundpattern for the munnopsids. The selection of a more appropriate outgroup and the reinterpretation of the presence of a anterior projection on the cephalon vertex has influenced this study and therefore a different result has occurred.

Within the Munnopsinae, Wägele (1989) considered *Munnopsoides* and *Acanthamunnopsis* to be sister groups within the Munnopsinae. In contrast, the results of the present analysis show *Munnopsoides* to be the sister group to *Pseudomunnopsis*.

2.4.2 Storthyngurinae–Acanthocopinae

Wilson's (1989) results showed that *Storthyngura* part of a polytomy with *Betamorpha*, *Ilyarachna* and *Amuletta*. *Acanthocope* formed a polytomy with *Munnopsurus*, *Paramunnopsis*, *Bellibos*, *Munneurycope*, the Lipomerinae and the *Storthyngura–Betamorpha–Ilyarachna–Amuletta* clade. In contrast, Wägele's (1989) results showed *Acanthocope* to be the sister group to *Microprotus*. Together *Microprotus* and *Acanthocope* are the sister group to *Storthyngura*, a result which is similar to those shown in the new analysis: *Acanthocope* is the sister group to the Storthyngurinae. Wägele also concluded that the Syneurycopinae was the sister group to the Storthyngurinae–*Acanthocope*, a result which is supported in analysis 2. This result, however, is dubious as the clade is defined by character states which are inapplicable to some of the included genera.

The Acanthocopinae and Storthyngurinae are sister groups in all four analyses, suggesting that at subfamily level, the presence of dorsal body spines do not influence their relationship and therefore, can be used to define this group.

2.4.3 Lipomerinae–Ilyarachninae–Eurycopinae–Bathyopsurinae and related genera

Wilson (1989) suggested that *Munnicope* could be the least derived munnopsid due to it having complete flexibility between pereonites 5–7 and pleotelson, and equally sized posterior pereonites with small musculature for the pereopods, but it was not included in his analysis. In Wägele's (1989) analysis *Munnicope* was included, and these results showed *Munnicope* in a polytomy which included all taxa except the Eurycopinae.

These results show that *Munnicope* is not the least derived munnopsid. In analyses 1 and 3 *Munnicope* is a basal group in the clade containing Ilyarachninae, Lipomerinae, Eurycopinae, Bathyopsurinae and related genera, while in analysis 4, *Munnicope* is the sister group to the clade with *Munneurycope*, Lipomerinae and Eurycopinae. In analysis 2, *Munnicope* groups with *Betamorpha* and *A. abyssorum*, although this relationship is doubtful as this clade is supported by two highly homoplasious characters: pereopod 1 robust;

and pleopod 3 endopod distal tip with more than 3 plumose setae. The pereopod 1 character has also not been coded for *B. acuticoxalis* and *M. calyptra*.

Wilson and Thistle (1985) suggested that *Amuletta* was the sister group to the then Ilyarachnidae. Wägele's (1989) results showed *Amuletta* and *Betamorpha* were sister groups, while Wilson's (1989) results showed that these two genera form a polytomy with *Storthyngura* and *Ilyarachna*. Kussakin (2003) created the subfamily, Betamorphinae, for *Amuletta* and *Betamorpha*. In all but one of the analyses presented here, *Betamorpha* does not align itself with *Amuletta* (and where it does, the results are equivocal, see above), and the latter genus is not as closely related to the Ilyarachninae as *Betamorpha*. Although *Betamorpha* aligns itself with the *Munnopsurus*–Ilyarachninae clade in all analyses except in analysis 2. This relationship however, should be treated cautiously. Firstly, because two characters supporting this clade are inapplicable to several of the included genera, and secondly two other characters are highly homoplasious. The inapplicable characters concern the mandibular palp characters an appendage that is missing in several genera of the Ilyarachninae.

Munnopsurus was hypothesised to be the sister group to *Baeonectes* by Wilson (1982). This was later rejected by Wilson (1989), whose results showed *Munnopsurus* was not included within the Eurycopinae clade. Wägele (1989) showed *Munnopsurus* to be the sister group of the Munnopsinae. The results in this study show *Munnopsurus* to be the sister group to the Ilyarachninae, except in analysis 2, where the genus splits up and the type species, *M. giganteus* aligns itself with *Munneurycope*.

While *Munnopsurus* is the sister group to the Ilyarachinae, many of the synapomorphic characters which define the *Munnopsurus* contradict the synapomorphic characters which define Ilyarachninae. This, therefore prevents Munnopsurus to be included within a wider definition of the the Ilyarachninae.

The sister grouping of the Eurycopinae and Lipomerinae together has not been proposed in the literature or found in previous studies, however, *Lipomera*, was once considered to be apart of the Eurycopinae (Wolff 1962). The grouping of these two subfamilies together was found in all analyses. The monophyly of the Eurycopinae is inconclusive. Even though this subfamily is monophyletic in

all but analysis 3, it does not have high bootstrap support. It would be beneficial to conduct a detailed phylogenetic analysis for this group with the Lipomerinae in order to resolve this question.

Wolff (1962) proposed that the Bathyopsurinae were most closely related to the *Munneurycope*. This group has received little attention, with no new species being described since *Paropsurus giganteus* Wolff, 1962. Bathyopsurinae was not included in Wilson's (1989) analysis and its placement remained unresolved in Wägele's (1989) study. Its position within the Munnopsidae is somewhat unresolved in analyses 1 and 3 and better resolved in analyses 2 and 4. Its sister grouping with the Syneurycopinae in analysis 4 is doubtful as several of the characters holding the clade together have not been scored for some of the species. The species representing Bathyopsurinae in this study also have the fewest scored characters of any group. It is, therefore, not possible to conclude its actual placement, apart from proposing it is more closely related to the Ilyarachninae–Eurycopinae–Lipomerinae and related genera group than to the remaining subfamilies in the Munnopsidae.

2.4.4 Syneurycopinae

The Syneurycopinae is a well defined and supported subfamily within the Munnopsidae. Wilson (1989) found that *Bellibos* (Syneurycopinae) was the sister group to *Paramunnopsis* (Munnopsinae) in a consensus tree with *a priori* weighting, but their relationship was unresolved in a consensus tree generated from successive weighting. None of the analyses show Munnopsinae as the sister group to Syneurycopinae. Wägele's (1989) analysis found that the Syneurycopinae grouped with Storthyngurinae–Acanthocopinae, which was found in analysis 2. In analyses 1 and 3, Syneurycopinae is in a polytomy with the other three main clades (mentioned as subtitles above), while in analysis 4 Syneurycopinae, is in a clade with Bathyopsurinae (discussed above).

2.5 A revised classification of the Munnopsidae

From this study it is clear that although some subfamily names are consistently shown to be monophyletic, others show no congruence between the

current nomenclature and the topology of the clades seen in these results. Retaining subfamily names becomes problematic, especially in clade 24 of analyses 1 and 2 (clades 25 and G, analyses 3 and 4, respectively). This clade contains 4 subfamilies, one of which is not supported and the three previously unplaced genera. Although the phylogenetic relationships are resolved between *Betamorpha*, *Munnopsurus* with the Ilyarachninae and between the Lipomerinae and Eurycopinae, the other subfamilies and genera remain in a polytomy with these two larger clades. The results do not permit a conclusive statement of the relationships between the taxa in the Munnopsidae. The results do suggest that the Munnopsidae has been 'oversplit' into subfamilies which, on present evidence, fail to retain their constituent taxa and are therefore not conceptually viable.

Here I recognize that there is a monophyletic group of families, the munnopsid-clade, within the Janiroidea, with the new families based on the results of analysis 1. Poore and Lew Ton (2002) suggested that the current higher family arrangements within the Asellota are uncertain. These results suggest that there are monophyletic groupings of families within the Janiroidea which means that there is the potential for further definition of superfamilies within the Asellota.

The munnopsid clade consists of the following families: Munnopsidae Lilljeborg, 1864, Syneurycopidae Wolff, 1962, Acanthocopidae Wolff, 1962 and Lipomeridae Tattersall, 1905a.

Munnopsid-clade

Diagnosis (after Wilson *et al*. 1989). Janiroidea with natasome: pereonites 5–7 enlarged, muscular, with segment articulations often broadly joined or fused; posterior ventral nerve chord ganglia fused into single mass in pereonite 5; pleotelson generally tapering posteriorly. Antenna 1 article 1 broad, laterally flattened. Pereopods 5–7 natatory (most genera), carpi and propodi expanded, fringed with long plumose setae; dactyli with trough-like hollow between superior and inferior claws enclosing distal sensillae.

Remarks. The subfamilies Acanthocopinae, Munnopsinae, Lipomerinae and Syneurycopinae are here elevated to families. This is the first recognition of the Acanthocopidae and Syneurycopidae as families. See Table 2.5 for family composition.

Key to the families of the munnopsid-clade

1. — Pereonites 1–4 nearly always wider than posterior pereonites; pereopods 5–7 propodus inferior margin with plumose setae towards distal margin only; pereopods 5–7 dactylus absent; male pleopods 2 somewhat fused together ……Munnopsidae Lilljeborg, 1864
   — Pereonites 1–4 never wider than posterior pereonites; pereopods 5–7 propodus inferior margin almost always with plumose setae along complete length of article (where plumose setae are present); pereopod 5 dactylus may be absent, but dactylus always present on pereopods 6 and 7; male pleopods 2 never fused together 2

2. — Antenna 1 article 1 sub-cylindrical, without distal lobes; maxilliped without coupling hooks; maxilliped palp article 3 mesial margin with denticles ..... Syneurycopidae Wolff, 1962
   — Antenna 1 article 1 not sub-cylindrical, instead broadened with flattened lateral flange and thickened medially, with none, 1 or 2 distal lobes; maxilliped with coupling hooks; maxilliped palp article 3 mesial margin without denticles 3

3. — Body elongate, oblong; pereonites 5–7 immovably fused, never swollen, antenna 2 article 3 with spine; dorsal spines prominent, pereonites 2–4 with at least 1 single central spine (except in *Acanthocope unicornis* Menzies, 1962 which has only a single central spine on pereonite 4), pereonites may have additional spines, but presence of central spine consistent ..... Acanthocopidae Wolff, 1962

— Body not elongate, more rounded than oblong; pereonites 5–7 never immovably fused, unless swollen; antenna article 3 spine absent; dorsal spines not so prominent within family, where spines are present, pereonites 2–4 without central spine ..... Lipomeridae Tattersall, 1905a

Family Acanthocopidae Wolff, 1962

Acanthocopinae Wolff, 1962: 109–110.— Kussakin, 2003: 264.

Storthyngurinae Kussakin, 2003: 273–274.— Malyutina, 2003a: 254.— Malyutina, 2003b: 2–3 **(new synonomy)**.

Diagnosis. Body elongate, length/width ratio less than 3.0, with dorsal and often lateral projections; ambulosome never wider than natasome; pereonites 2–4 dorsally with at least one single median spine; pereonites 5–7 and pleon immovably fused, although dorsal sutures may be visible; natasome never swollen. Antenna 1 article 1 with 1 distal lobe; antenna 2 article 3 with spine, antennal scale either fused or absent, never free. Maxilliped endite with coupling hooks; palp article 3 without denticles. Pereopods 5–7 with dactylus. Male pleopods 2 never fused together. Distal margin of pleon with projection. Uropodal protopod elongate, rod-like, never flattened.

Genera included. *Acanthocope* Beddard, 1885; *Microprotus* Richardson, 1910; *Rectisura* Malyutina, 2003a; *Storthyngura* Vanhöffen, 1914; *Storthyngurella* Malyutina, 1999b; *Sursumura* Malyutina, 2003a; and *Vanhoeffenura* Malyutina, 2003a.

Remarks. The family Acanthocopidae can be identified by and distinguished from the other families in the munnopsid-clade by: body with dorsal and often lateral projections; median dorsal spine present on pereonites 2–4 (except in *A. unicornis* which only has one median dorsal spine on pereonite 4); and antenna 2 article 3 with spine. The Acanthocopidae requires a detailed phylogenetic analysis to further redefine the genera.

Family Lipomeridae Tattersall, 1905

Lipomeridae Tattersall, 1905a: 600.

Ilyarachini Hansen, 1916: 120–121.

Eurycopini Hansen, 1916: 129–130.

Bathyopsurinae Wolff, 1962: 170.

Ilyarachnidae.— Wolff, 1962: 93.— Menzies, 1962: 155.— Menzies and George, 1972: 9.76.— Schultz, 1976:1–2.

Eurycopidae.— Wolff, 1962: 108–109.— Menzies, 1962: 138.— Menzies and George, 1972: 9.50.

Eurycopinae.— Wolff, 1962: 117.— Kussakin, 2003: 20–21.

Lipomerinae.— Wilson, 1989: 22.— Kussakin, 2003:155–156.

Ilyarachninae.— Kussakin, 2003: 187–188.

Betamorphinae Kussakin, 2003: 142.

Diagnosis. Body length/width ratio less than 3.0, rarely with dorsal and lateral projections; pereonites 2–4 either spineless or with many spines, never with central spine; pereonites 5–7 and pleon can be free, partially fused or fully fused, but usually retain some degree of flexation, if pereonites 5–7 immovable, natasome swollen. Antenna 1 article 1 with none, 1 or 2 distal lobes; antenna 2 article 3 spine absent; antennal scale either present or absent. Maxilliped with coupling hooks; palp article 3 without denticles. Pereopods 5 with or without dactylus; pereopods 6 and 7 dactylus always present. Pleon usually without distal projection, if present, small and spine-like. Male pleopods 2 never fused together. Uropods usually small, either tubular or flat and leaf-like.

Genera included. *Amuletta* Wilson and Thistle, 1975; *Aspidarachna* Sars, 1897b; *Baeonectes* Wilson, 1982; *Bathybadistes* Hessler and Thistle, 1975; *Bathyopsurus* Nordenstam, 1955, *Belonectes* Wilson, 1982; *Betamorpha* Hessler and Thistle, 1975; *Coperonus* Wilson, 1989; *Disconectes* Wilson and Hessler, 1981; *Echinozone* Sars, 1897b; *Eurycope* Sars, 1864; *Hapsidohedra* Wilson, 1989; *Ilyarachna* Sars, 1870; *Lionectes* Wilson, 1989; *Lipomera* Tattersall, 1905a; *Mimocopelates* Wilson, 1989; *Munneurycope* Stephensen, 1913;

Munnicope Menzies and George, 1972; *Munnopsurus* Richardson, 1912; *Notopais* Hodgson, 1910; *Paropsurus* Wolff, 1962; *Pseudarachna* Sars, 1897b; and *Tytthocope* Wilson and Hessler, 1982.

Remarks. The Lipomeridae is the largest family in the munnopsid-clade, both in number of genera and in total number of species. The combination of characters which distinguish the Lipomeridae from the other munnopsid-clade families are: pereonites rarely with dorsal and lateral projections; pereonites 2–4 either spineless or with many spines, never with central spine; antenna 2 article 3 spine absent; maxilliped with coupling hooks; pereopods 6 and 7 dactylus always present; and male pleopods 2 never fused together.

Family Munnopsidae Lilljeborg, 1864

Munnopsidae Lilljeborg, 1864: page 6 (part).— Sars, 1897b: 131–132 (part).— Wolff, 1962: 183.— Menzies and George, 1972: 9.89.— Wilson *et al*., 1989: 340 (part).

Acanthamunnopsidae Schultz, 1978: 75.

Munnopsini.— Hansen, 1916: 152.

Munnopsinae.— Kussakin, 2003: 317.

Diagnosis. Body rectangular, length/width ratio between 2.0 and 4.0, lateral projections can be present; ambulosome always wider than natasome; pereonites 2–4 without spines; pereonites 5–7 fused with pleon, dorsal sutures may be visible; natasome never swollen. Antenna 1 article 1 with 1 distal lobe; antenna 2 article 3 spine absent; antennal scale present, free. Maxilliped endite with coupling hooks; palp article 3 without denticles. Pereopods 5–7 without dactylus. Pleon with or without distal projections. Male pleopods 2 somewhat fused together. Uropods tubular, rod-like, either small or elongate.

Genera included. *Acanthamunnopsis* Schultz, 1978; *Munnopsis* Sars, 1861; *Munnopsoides* Tattersall, 1905a; *Paramunnopsis* Hansen, 1916; and *Pseudomunnopsis* Hansen, 1916.

Remarks. The family Munnopsidae can be distinguished from the other families in the munnopsid-clade by: the ambulasome always wider than the natasome; pereopods 5–7 without dactylus; and male pleopods 2 fused.

Family Syneurycopidae Wolff, 1962

Syneurycopinae Wolff, 1962: 116.— Haugness and Hessler, 1979: 125.— Kussakin, 2003: 174.

Diagnosis (amended from Haugness and Hessler, 1979). Body elongate, length/width ratio more than 3.0, with no distal or lateral projections; ambulosome sub-equal or narrower than natasome, never wider; pereonites 5–7 fused, natasome never swollen. Antenna 1 article 1 more sub-cylindrical, with no distal lobes. Antenna 2 article 3 with no spine; antennal scale absent. Maxillipeds without coupling hooks, may be fused in part; palp article 3 with medial denticles. Pereopods 5–7 with dactylus. Pleon with no distal projection. Male pleopods 2 never fused together. Uropods flattened, not tubular and rod-like.

Genera included. *Bellibos* Haugsness and Hessler, 1979; and *Syneurycope* Hansen, 1916.

Remarks. The Syneurycopidae can be distinguished from the other families in the munnopsid-clade by: antenna 1 article 1 more sub-cylindrical with no distal lobes; maxillipeds without coupling hooks; and maxilliped palp article 3 with medial denticles. This family is the smallest of the munnopsid-clade.

2.6 Conclusions

The analysis of the family Munnopsidae found that *Munnopsurus* is the sister group to the Ilyarachninae and *Betamorpha* the sister group to this clade, although the latter should be viewed with some caution. A wider definition of the Ilyarachninae to include *Munnopsurus* is not possible, due to conflicting synapomorphic characters of the respective groups. This conclusion is similar to that of Wilson (1989), who recognised the Ilyarachninae as a unique

phylogenetic unit and did not expand their definition to include any other closely related sister taxa.

Within the family, the Munnopsinae, and not the Eurycopinae was found to be the least derived of the munnopsids. Of all the subfamilies, Betamorphinae was found to be not monophyletic. This analysis, has, in part, resolved the placement of the three *incertae sedis* genera *Munnicope*, *Munnopsurus* and *Munneurycope*. *Munnopsurus* is the sister group to the Ilyarachninae and *Munnicope* is the least derived of the Lipomeridae, however, the position of *Munneurycope* within the Lipomeridae is unresolved.

The results from this analysis has shown that subfamily names are not warranted, and are therefore abandoned. To maintain continuity with the main theme of this study, the term *Ilyarachna*-group (equivalent to the former Ilyarachninae) will be used throughout the rest of this thesis.

Chapter 3: A phylogenetic revision of the *Ilyarachna*-group

3.1 *Ilyarachna*-group of the south-west Pacific Ocean

Although, the first munnopsid isopods from the south-western Pacific were collected during the round-the-world-voyage of the HMS *Challenger* in the early 1870s (described in Beddard 1886), the first *Ilyarachna*-group specimens were collected by the Danish deep-sea *Galathea* Expedition between 1950–52. *Ilyarachna kermdecensis* Wolff, 1962 was collected from three stations in the Kermadec Trench at depths between 4540–7000 metres (Wolff 1962). Monod (1973) illustrated a species off the eastern Australian coast, although he did not formally name it. Until this present study, Monod's (1973) record and *I. kermadecensis* have remained the only *Ilyarachna*-group known from this region.

This paucity of records for the *Ilyarachna*-group from the south-western Pacific is indicative that this group has been little studied in the region. This does not relate to the actual diversity of this group in the region. Surveys of the south-eastern Australian continental slope suggest a high level of isopod diversity. Poore *et al*. (1994) calculated (using the rarefaction methods of Hurlbert 1971) 25 expected species from 100 individuals. From 46 samples, Poore *et al*. (1994) found 359 species from 36 families with less than 10% being identified to known species. Of the 359 species, 20 species are from the *Ilyarachna*-group (pers. obs.). Inspection of the shelves at the National Institute of Water and Atmospheric Research biological collections (Wellington, New Zealand), have revealed 13 species of Ilyarachninae mostly collected from New Zealand's Exclusive Economic Zone (EEZ; pers. obs.).

Recent sampling of the isopod fauna from other Southern Hemisphere regions, namely the Angola Basin, the Southern Ocean and the Antarctic (Weddell Sea) show that munnopsid-clade isopod species are prevalent and can be the most dominant isopod group collected (Brandt *et al*. 2004; Castelló 2004; Brandt *et al.* 2005). Brandt *et al*. (2004) sampled at several Southern Ocean

localities, all in the South Atlantic sector and found that the species of the munnopsid-clade dominated, making up 61% of all the isopod specimens. This group was also the most diverse with 118 species representing 28 genera, but only 37 (including four species of *Ilyarachna* and three species of *Notopais*, referred to as *Echinozone* in the paper) had been previously described (Brandt *et al*. 2004).

3.2 General Biology of the *Ilyarachna*-group

3.2.1 Diet

The *Ilyarachna*-group have enlarged, heavy and calcified mandibles that are supported by large musculature in the cephalon. The incisor process is modified from the plesiomorphic janiroidean condition, which has defined cusps (Wilson 1989), to being generally smooth and rounded with no defined cusps.

Wolff (1962) concluded that deep-sea benthic isopods were deposit feeders, and found that the intestinal content in *I. kermadecensis* (the only ilyarachnine included in his study) was detritus (which he termed as rare), minerals (very rare), foraminifers (very rare), spicules of sponges (rare) and possibly fragments of crustacean mouthparts and fragments of integument (rare).

More recently, diet related studies which have included *Ilyarachna* species, have all found that foraminifers are an important component of their diet (Svavarsson *et al.* 1993; Gudmundsson *et al.* 2000; Cartes *et al.* 2001). Foraminivery is now thought to be more widespread amongst deep-sea isopods than previously thought (Gudmundsson *et al*. 2000) with foraminifers being reported in the gut contents of several species (also see Menzies 1956a; Menzies 1956b; Wilson and Thistle 1985; Brandt 1997). Wolff (1962) had considered that the foraminifers were being consumed accidentally.

While all *Ilyarachna*-group can crush foraminifers with their mandibular molar process, Gudmundsson *et al*. (2000) found that observed differences in the *Ilyarachna*-group molar can be related to diet preferences, with a species targeting certain foraminifer species or genera. They found that the most common type of foraminifers in the gut content of *Echinozone arctica* Hansen,

1916 were calcareous and hard agglutinating foraminifers, which they linked to the mandibular molar being better adapted to crushing shells than the molar of the other two species they studied, *Ilyarachna bergendali* Ohlin, 1901 and *Ilyarachna torleivi* Svavarsson, 1988. Gudmundsson *et al*. (2000) found that soft-shelled and agglutinating foraminifers were more common in the gut contents of *I. bergendali*. They found that the gut contents of *I. torleivi* were more similar to *I. bergendali* and they linked this similarity to the structure of the molar. In addition to being able to crush their food, the molar of both species has a sharp cutting edge, which Gudmundsson *et al*. (2000) concluded would be more advantageous when targeting those foraminifers with a more soft and flexible shell.

3.2.2 Predation

Ilyarachna-group species have been found in the gut contents of the two deep water species of Mediterranean fish: *Cataetyx alleni* (Byrne, 1906) (Carrassõn and Matallanas 2002) and *Bathypterois mediterraneus* Bauchot, 1962 (although it is thought to be an accidental prey item in the latter; Carrassõn and Matallanas 2001), the deep-sea brachyuran crab *Geryon longipes* Milne Edwards, 1882 (Cartes 1993) and rat-tails (family Macrouidae) (M. Jones and A. Connell, pers. com.).

3.2.3 Behaviour

Hessler and Strömberg (1989) studied the behaviour of several asellote species including *I. longicornis*, *Pseudarachna hirsuta* and an unidentified species *Echinozone* species from Antarctica. In this study they found that: respiration was sporadic; brooding females ventilate the marsupium and redistribute the embryos inside by expanding and contracting the brood chamber; the flagellum of antenna 2 was kept clean by either the mouthpart endites (they do not specify which ones), the mandibular palp or the first two pereopods; and that their pereopods were cleaned of detritus (except in the family Munnidae) by the appendages of the mouth field.

3.2.4 Locomotion

The *Ilyarachna*-group have an enlarged and streamlined natasome, and pereopods 5 and 6 (and to a lesser extent 7) are modified for swimming, that is, these pereopods have flattened carpi and propodi that are fringed with long plumose setae. When *Ilyarachna*-group species swim, they swim backwards, with their elongate pereopods 3 and 4 and long second antennae trailing behind them. This swimming style has been recorded in many species of munnopsid (see Sars 1899; Hult 1941; Hessler and Strömberg 1989; Hessler 1993; Marshall and Diebal 1995; Giver 1998). Hessler and Strömberg (1989) found *Echinozone* sp. and *I. longicornis* to be reluctant swimmers, meaning they would only swim when provoked by prodding and concluded that swimming was probably an escape mechanism. Walking in these two species was mainly done with pereopods 3 and 4, however, *Echinozone* sp. also partially used pereopod 2 (but this may be only to probe the bottom), while in *I. longicornis* pereopods 5–7 participated slightly (Hessler and Strömberg 1989).

3.2.5 Burrowing

Ilyarachna-group species burrow backwards into the substrate, using their posterior pereopods to propel them down into the sediment (Hessler and Strömberg 1989). The resting position when buried for *I. longicornis* and *Echinozone* sp. is similar, with pereopods 3 and 4 and antenna 2 radiating out on the surface. In *P. hirsuta*, however, pereopod 3 is positioned out to the side and pereopod 4 is stretched out over the back, but antenna 2 was in a similar position to that found in the other *Ilyarachna*-group species (Hessler and Strömberg 1989).

3.2.6 Symbionts

Ólafsdóttir and Svavarsson (2002) found ciliates to be common epibionts on *I. bergendali*, *I. hirticeps* and *I. torleivi*, with between 37–68% of specimens sampled hosting ciliates. These specimens hosted seven species of ciliates, with peritrichs being the most common type found, as well as chonotrichs and apostomids. Some ciliate species showed no preference to where on the body

they were located, although one species lived entirely on the antennae, while others were restricted to the posterior pereopods. Foraminifers have been found on *I. hirticeps*, although this was a very rare occurrence (Svavarsson and Daviðsdóttir 1994).

3.2.7 Reproduction

Little is known about the breeding cycles of the *Ilyarachna*-group. Wolff (1962) studied a large number of Paraselloidea, mostly collected over a number of summer months from the North Atlantic, and found low numbers of ovigerous females and females with oostegites, compared to those without oostegites. From this, Wolff (1962) concluded that asellotes were, to an extent, seasonal reproducers in the North Atlantic, with the peak breading season during winter. George and Menzies (1967; 1968a) also concluded that deep-sea isopods exhibit seasonal breeding cycles, but Sanders and Hessler (1969) dismissed George and Menzies' work due to their small sample size. Sanders and Hessler (1969) studied *Ilyarachna* sp. from the Gayhead–Bermuda transect and concluded that reproduction in this species is continuous, showing no seasonal peaks. Rokop (1977) also doubted George and Menzies' (1967; 1968a) conclusions of seasonal breeding cycles except for that of *Vanhoeffenura birsteini* (Menzies, 1962) which he found to be statistically significant to be considered a seasonal breeder. Rokop's (1977) study included *Ilyarachna profunda* Schultz, 1966 from the San Diego Trough, and he concluded that this species was a year round breeder. Harrison (1988) considered Rokop's results to be statistically weak, and presented new data gathered over a 10-year time-span on Asellota from the Rockall Trough in the north-east Atlantic. Harrison (1988) found that although breeding was not seasonal, breeding intensity was, with the proportion of brooding females increasing from a summer low through to a winter high and hypothesised that this was linked to environmental cueing.

Cartes *et al.* (2001) studied samples of *I. longicornis* from the Bay of Biscay and the Catalan Sea and also found evidence for continuous breeding in the Atlantic. This study found that both female and juvenile densities display two peaks (adult females: March and July; and juveniles: April and July). The second

peak of adult females was seven times higher in July than in March, and then nearly vanished in August. From this they concluded that *I. longicornis* is fast growing and short lived, with two generations a year, the first generation living for between 3–4 months and the second generation 7–8 months.

From these results, it can be generally concluded that the *Ilyarachna*-group are potentially continuous breeders which go through a cycle of breeding intensity.

3.3 Morphology of the *Ilyarachna*-group

Cephalon.– The cephalon is trapezoidal in dorsal view, widest posteriorly. Eyes are always absent. The cephalon is sculptured and has a defined central dome except in *Aspidarachna* which is smooth and shield-like. Ornamentation being either robust or stout setae or varying numbers of spines can be present. Ventrally, the shape of the frons can vary between genera. It is generally short and broad, almost rectangular but in *Pseudarachna*, it is wide and semi-circular, while in *Aspidarachna* it is very narrow, and in *Echinozone* it is elongate and trapezoid.

Body.– The body of the *Ilyarachna*-group has two well-defined parts the anterior four pereonites and the posterior three pereonites that, together with the pleon, form the natasome. Ornamentation in the form of spines or robust setae may occur along the anterior margins of the pereonites 1–5. The body is generally smooth, but can be granular or covered in small setae. Pereonite 6 is usually ventrally smooth, but may have either a medial spine or setae. Pereonite 7 generally shows three different ventral states: it can be devoid of ornamentation, have a single elongate spine (present in many species of *Ilyarachna*), or a row of setae (present in many species of *Notopais*), but there are some species-level exceptions. Pleonite 1 is always present and is usually devoid of ornamentation, except in *Nyctobadistes* n. gen. and in some species of *Notopais*, where spines maybe present.

Pleon.– Always triangular with a medial rounded keel. Dorsal ornamentation may vary.

Antennae.– Antenna 1 is sexually dimorphic, with the flagellum longer in

males than in females. The first article is the largest and setation varies between species. Antenna 2 is rarely found to be complete, often breaking off after the fourth article. Articles 1–4 are short and the general shape articles 2–4 are uniform throughout the subfamily. The shape of article 1 varies between genera, from *Notopais* having a prominent 'horn-like' spine on the lateral margin to this margin being straight and having no spine.

Mouthparts.– The mandible incisor is distinctly massive and rounded and not dentate. The lacinia mobilis is absent in *Aspidarachna*, *Epikopais* n. gen., *Pseudarachna* and many species of *Notopais*. When present, the lacinia mobilis is greatly reduced. The spine row is absent in *Aspidarachna*, *Pseudarachna* and in many species of *Notopais*. The mandibular molar is small, with varying numbers of terminal setae. The presence or absence of the mandibular palp is an important defining generic character in the *Ilyarachna*-group, and it is present *Aspidarachna*, *Bathybadistes*, *Ilyarachna* and *Nyctobadistes*.

Maxilla 1 and maxilla 2 are remarkably uniform in shape throughout the group. Maxilla 1 consists of a larger lateral endite and a smaller mesial endite. The distal setal types of the lateral endite differ between species, although the lateral three setae are always large, smooth and robust. The mesial endite always has two distal pectinate setae. Maxilla 2 consists of three endites, the lateral and middle endites being of similar size while the mesial endite is larger. The lateral and middle endites each have four terminal elongate setae, while the mesial endite has varying numbers of toothed and simple setae, with the most mesial seta is always an elongate pectinate seta.

The maxilliped is uniform in shape throughout the group. The number of coupling hooks varies between species, as does the number of fan setae present on the distal margin of the basal endite. The palp always has five articles, with article 2 being the largest. The mesial margin of the article 3 is generally the most setose, with the greatest number of distally pappose setae.

Pereopods.– Pereopods are of two forms: the ambulatory anterior four and the natatory posterior three. Pereopods 3 and 4 are typically the longest, except in *Pseudarachna* where pereopod 2 is the longest. This elongate, robust pereopod 2, with a shortened ischium is characteristic to *Pseudarachna*.

Pleopods.– The female operculum is typically boat shaped with a medial keel that usually has a row of robust setae running down the ridge and has elongate plumose setae down the lateral margins. Male pleopods 1 and 2 are also typically uniform in shape, in pleopod 1 the differences occur in ventral and distal ornamentation of the rami, while in pleopod 2 the length and shape of the stylet can differ within *Epikopais* and *Ilyarachna*. The shape of pleopods 3–5 is similar within the *Ilyarachna*-group, however, the number of plumose setae on the endopod and exopod of pleopods 3 and exopod of pleopod 4 can differ between species.

Uropods.– The uropods are lamellar and flat with have varying numbers of both plumose and simple setae along the margins. They can either be uniramous or biramous, with either a rudimentary exopod, as found in some *Ilyarachna* and *Bathybadistes* to a fully articulated article as found in *Echinozone* and *Notopais*.

3.4 Methods

Owing to their fragile nature, specimens rarely survive the collecting and sorting process fully intact. Pereopods 2–4 and antenna 2 are almost always lost, with specimens often retaining only the basis of the pereopods and the peduncle of the antenna. Just over half of the known species of *Ilyarachna*-group have two or more pereopods illustrated, with pereopod 1 the most commonly drawn. Uropods are also frequently lost from specimens. Many species are only known from a single sex, and thus potentially valuable sexually dimorphic characters remain unknown for the opposite sex in that respective species. It was, therefore, impossible to construct an inclusive list of characters which covered all aspects of *Ilyarachna*-group morphology. Even with a restricted character set, species were still excluded due to either poor material or literature descriptions which were not detailed enough to provide a comprehensive scoring of character states. I set the threshold for inclusion in the analysis at 80% of characters scored.

3.4.1 Taxa included

Ingroup

Fifty-nine species from a total of 80 were included in the analysis which represented all genera, including the two new genera, *Epikopais* n. gen. and *Nyctobadistes* n. gen. and 22 new species (present study). Type species were included for all genera except *Bathybadistes*, as *Bathybadistes hoplitis* Hessler and Thistle, 1975 is not adequately described in the literature. Refer to Appendix 3.1 for a full species list and references.

Outgroup

Outgroup selection was based on the results of the analysis presented in Chapter 2, where *Betamorpha* and *Munnopsurus* form a clade with the *Ilyarachna*-group. Although the sister-group relationship *Betamorpha* has with *Munnopsurus*–Ilyarachninae should be treated with some caution, the inclusion of *Betamorpha* as an outgroup in this analysis is still useful. Two species from each genus were selected: *Betamorpha characta*; *Betamorpha acuticoxalis*; *Munnopsurus giganteus*; and *Munnopsurus laevis*. The references used for these species are referred to in Appendix 2.1.

3.4.2 Character discussion

Sixty-one morphological characters were used. All were unordered and unweighted, with 46 characters being binary and 15 characters with three or more states. Characters are discussed in detail below and are individually listed with states and respective figures in Appendix 3.2.

Body and cephalon

A clypeus with a small arch just in the centre (character 1; Fig. 3.3D) and the trapezoid shape of the cephalon (character 2) are two synapomorphies which define the ingroup in the results presented in Chapter 3.

Generally the frons is short, slightly trapezoid and broad (character 3; Fig. 3.1D). In *Pseudarachna*, the frons is enlarged and semi-circular (Fig. 3.1B), and it is one of the characters used by Sars (1897b) to distinguish this genus. *A.*

clypeata has a narrow frons, with a defined ridge around the antennae (Fig. 3.1A). It is unknown if this occurs in other *Aspidarachna* species as the frons has not been illustrated for other species.

The presence of dorsal spines and setae on the cephalon (characters 4 and 5) should be useful in determining closely related groups of species. The dorsal surface of the cephalon of *A. clypeata* has an even surface with no sculpting or defined areas (character 6; Fig. 3.1H) and anterior flanges are absent (character 7; Fig. 3.1H). Two new species of *Epikopais*, have large, extended flange-like structures on the anterior region of the cephalon (character 8).

Dorsal spines, with or without an apical seta (character 23), and robust setae are present in many species of *Ilyarachna*-group, and are usually found on the anterior margins of the pereonites 1–4 (characters 9 and 10). One exception is *Ilyarachna taranui*, which has an unusual dorsal spine pattern, as spines present only on pereonites 2 and 4 instead of all four pereonites. This is considered a rare polymorphism, and in this analysis, this species has been scored to have dorsal spines on pereonites 1–4. Pereonite 5 anterior margin can be either smooth, have dorsal spines or robust setae (characters 15 and 16). Spines and setae can also be found ventrally on pereonite 7 (characters 21 and 22).

One character which Sars (1897b) used to distinguish *Pseudarachna* from the other genera was the enlarged pereonite 2 (character 11; Fig. 3.1G). A north Pacific group of *Echinozone* shares a uniquely shaped pereonite 4 which does not resemble pereonite 3, but instead is directed toward the posterior margin (character 12; Fig. 3.1I). The lateral margins of pereonite 5 in this group narrows anteriorly and forms an elongation or 'neck' (character 17; Figs 2.3A and 3.1I).

In *A. clypeata* and *Aspidarachna carinata* (Birstein, 1963) pereonites 1–4 are short and compact (character 13). The size and shape of pereonite 5 in relation to pereonite 6 should be important in distinguishing closely related species (characters 14 and 20).

The lateral margins of pereonites 5–7 can be somewhat narrow making these pereonites more distinct from each other and the natasome less streamlined (character 18; Figs 2.2J and 2.3A). In *Bathybadistes*, these margins form an

single elongate spine or are jagged with many spines (character 19; Figs 2.3J and 3.1J, respectively).

Antennae

The antennae of *Pseudarachna* are separated by a wide interantennal gap and are not positioned in the centre of the cephalon (character 24). Antenna 1 of this genus is unique, as it is much smaller than in other related genera (character 25). Article 1 in *Pseudarachna* has a large lateral lobe (character 27; Fig. 3.1L) rather than a distal point (character 26). Antenna 1 article 3 is elongate and longer than article 1 in several species (character 28).

Article 1 of antenna 2 (character 29; Fig. 2.4B) has a prominent horn-like spine with an apical robust seta, an apomorphic state defined by Merrin (2004b) for the genus *Notopais*. Some *Notopais* species also have a spine on article 2 (character 30).

Mouthparts

Characters 31 and 34 (both illustrated in Fig. 2.4C) are mandible characters defining the ingroup. In *Epikopais*, the mandibular fossa is curved, running laterally down the mandible (character 32; Fig. 3.2C).

The lacinia mobilis (character 33), the mandibular spine row (character 35) and the mandibular palp (character 36) have been lost in several species and combinations of presences and losses were used by Sars (1897b) to define genera. Within *Ilyarachna* the relative length of the mandibular palp articles and their arrangement of setae are useful in defining species groups (characters 37–39).

Pereopods

Pereopod 1 is the most commonly illustrated pereopod in the literature for the *Ilyarachna*-group as it is the pereopod most often preserved. Characters 40–42 concern aspects of size and setation of pereopod 1 segments.

An enlarged and robust pereopod 2 with a short, thick ischium is an apomorphy for *Pseudarachna* (character 43). Characters 44 and 45 refer to

pereopodal characters which differentiate the ingroup from the outgroup genera.

Pleon and pleonites

The pleon can be dorsally ornamented (character 46) or smooth. In *Bathybadistes* the anterolateral corners of the pleon each have a spine and distal seta (character 47; Figs 2.2J and 3.1J) and distally the pleon has a projection (character 48; Fig. 2.2J).

Pleopods

Two species, *Epikopais waringa* n. sp. and *Epikopais mystax* n. sp., have a prominent, wide and bulbous opercular keel (character 49; Fig. 3.2E).

In males, the lateral rami of pleopod 1 can extend past the mesial rami (character 50). In many species of *Ilyarachna* and *E. waringa*, the stylet of male pleopod 2 hooks up into the proximal half of the protopod (character 51; Fig. 3.2F). In other species, even if it does not hook up, it can still be long enough to extend beyond the distal margin of the protopod (character 52). Characters 53 and 54 refer to setation on pleopods 3 and 4.

Uropods

Uropodal characters have long been used to distinguish genera within the *Ilyarachna*-group (for example, see Sars 1897b), with one of the most important characters being either the presence or absence of an exopod (character 61; Fig. 2.6D). The uropodal protopod is flattened (character 58) with the rami positioned on the distolateral margin (character 60). Uropod size, shape and setal patterns should provide insights into species relationships (characters 55–57).

3.4.3 Cladistic analysis

The same methods presented in Chapter 2.2.3 were used to construct the data matrix (see Table 3.1) and to conduct both the unweighted and successively weighted character analyses. As the outgroups represent two different genera, the default OUTROOT command was used (OUTROOT=POLYTOMY). A bootstrap analysis was only run for the successively weighted analysis under the

same constraints as presented in the analyses in Chapter 3. Unlike the munnopsid analysis, the dataset was not modified and re-analysed.

3.5 Results

3.5.1 Analysis of the *Ilyarachna*-group with discussion of clades

This analysis does not support the monophyly of *Aspidarachna*, *Ilyarachna* and *Echinozone*. It does support the monophyly of *Bathybadistes*, *Notopais*, *Pseudarachna*, *Epikopais* and the monotypic *Nyctobadistes*. This analysis does not resolve the proposition that *Ilyarachna* is the most basal genus of the *Ilyarachna*-group as put forward by Thistle and Hessler (1976).

The unweighted analysis found 625 most parsimonious trees of tree length of 216, with a CI of 0.21 and a RI of 0.40. One character, character 6, was found to be parsimony uninformative. The strict consensus tree (Fig. 3.3) is poorly resolved with more than half the species forming a large polytomy. There is some structure in a clade including *Bathybadistes* and some *Echinozone* species. Both *Pseudarachna* and *Epikopais* are monophyletic in this analysis.

The successively weighted analysis yielded 2926 most parsimonious trees with an improved CI of 0.7 and a RI of 0.88. The strict consensus tree is better resolved (Fig. 3.4) than the strict consensus tree found from the unweighted analysis, and forms the basis of all further discussion. Reweighting of the characters lead to 25 being given the weight of 1.0, 15 were given a weight between 0.2 and 1.0, 20 characters were given a weight of less than 0.2 and 1 character was given a weight of 0 (Table 3.2).

Not all the clades seen in Fig. 3.4 will be discussed below in detail (see Table 3.3 for a detailed summary of characters defining clades and terminal taxa). Clade numbers discussed below refer to those found in the analysis. Bootstrap values over 50 are mentioned in brackets.

There are four large clades: clades 4, 10, 32 and 46. Clade 4 is a trichotomy of *Aspidarachna*, *Epikopais* and *Pseudarachna*, and is defined by: frons enlarged, semi-circular; left mandible with lacinia mobilis absent; mandibular spine row absent; and uropod exopod article large, articulating. It is

significant to note that some of these character states do not define all the species within this clade.

These results show that *Aspidarachna* is not monophyletic and its representative species are split into two groups, clade 5 and one species with clade 6. Clade 5 (80) contains *Aspidarachna clypeata* and *Aspidarachna carinata* (Birstein, 1963) and is supported by: frons narrow, with defined ridge around antennae, ridge almost meeting mandibles; anterior cephalic flanges absent, instead with even ridge; and pereonites 1–4 short, compact.

Clade 6 (61) contains *Aspidarachna glabra* (Birstein, 1971) and *Epikopais* and is defined by: frons short, laterally rounded; mandibular fossa curved, running laterally along mandible; mandibular palp article 2 length sub-equal or shorter than length of article 1; mandibular palp article 3 with no row of short setae along margin; and pleopod 4 exopod with 1 plumose seta. It is significant to note that some characters defining this clade, in particular those concerning the mandibular palp, are inapplicable to *Epikopais*.

Clade 7 (88) is *Epikopais* and is defined by: pereonites 1–4 anterior margins with simple setae; antenna 1 article 1 distally rounded, sub-cylindrical with 1 distal point; mandibular palp absent; and pereopod 1 carpus, inferior margin with neither dense setal row or elongate setae concentrated in proximal region of carpus.

Pseudarachna (clade 9; 100) is monophyletic and is defined by the following character states: cephalon dorsally with simple setae; anterior cephalic flanges absent, ridge absent; pereonites 1–4 anterior margins with dorsal spines; pereonite 2 larger than pereonite 3; pereonite 5 dorso-medial length sub-equal or longer than pereonite 6; antennae inserted not towards middle of cephalon, but out wide, with a large interantennal gap; antenna 1 reduced in size; distally antenna 1 article 1 with no distal points; antenna 1 article 1 with large lateral extension; mandibular palp absent; pereopod 1 propodus longer than carpus; pereopod 2 enlarged, robust, ischium short, thick, not much longer than merus; and uropod exopod absent.

Clade 10 contains species of *Echinozone*, *Ilyarachna*, *Nyctobadistes*, *Bathybadistes* and *Notopais* and is defined by: pereonites 1–4 anterior margins

with dorsal spines; pereonite 5 anterior margin with spines; and uropod protopod less than twice width.

Echinozone is not monophyletic, with the type species *E. coronata*, separate from the other *Echinozone* species. *E. coronata* is distinguished by: frons elongate, trapezoid; spines/tubercles on pereonites without apical setae; mandibular palp absent; pleopod 3 endopod with 3 or less setae; pleopod 4 exopod with 1 plumose seta; and uropod exopod article large, articulating.

Clade 12 is defined by characters which are inapplicable to some of the species contained within this clade. It is defined by: pereonite 5 anterior margin with no spines; mandibular palp article 2 without short pectinate setae; and mandibular palp article 3 with no row of short setae along margin. However, the latter two characters are not applicable to either *Notopais* or *Echinozone* within this clade.

Bathybadistes (clade 18; 96) is monophyletic and is distinguished by the following synapomorphies: if narrowing and distinct from each other, pereonites 5–7 lateral margins narrow, elongate, akin to a single spine; antenna 2 article 1 distolateral angle with small spine and robust seta; pleon anterolateral corners with spine and distal seta; pleon distal margin with projection. *Bathybadistes* is the sister group to *Nyctobadistes* (clade 17; 71). Clade 17 is defined by: pereonite 5 anterior margin without spines; antenna 2 article 2 with spines; uropod protopod triangular, wider proximally than distally; and uropod exopod rudimentary. The latter two characters, however, are unknown in *Nyctobadistes* as the uropod is not known for this genus.

Nyctobadistes and *Bathybadistes* together are the sister group to a monophyletic group of *Echinozone* species (clade 20; 97). Together they form clade 16 (73) and this clade is defined by: dorso-centrally, pereonite 5 length sub-equal or longer than pereonite 6; pereonites 5–7 lateral margins narrowing, pereonite margins distinct from each other; mandibular palp article 2 length sub-equal or shorter than length of article 1 (inapplicable to the *Echinozone* species within this clade); and pleopod 3 endopod with 3 or less setae.

Clade 20 (97) is defined by: pereonite 4 directed toward posterior margin; pereonite 5 lateral margins narrowing anteriorly, forming an elongation or 'neck';

antenna 1 article 1 distally rounded, sub-cylindrical with 1 distal point; antenna 1 article 3 length equal or more than article 1; mandibular palp absent; pereopod 1 carpus, inferior margin with a dense row of setae; and uropod protopod length less than twice width.

Clade 23 contains *Ilyarachna zachsi* Gurjanova, 1933 which is the sister species to *Notopais*. This clade is defined by: antenna 2 article 1 distolateral angle with horn-like prominent spine and robust seta.

Notopais (clade 24) is defined by: pereonite 5 anterior margin with spines; antenna 1 article 1 distally rounded, sub-cylindrical with 1 distal point; mandibular palp absent; uropod protopod mesial margin with few to no plumose setae, never many in a row on lateral margin; and uropod exopod article larger, articulating.

Clade 32 consists of only *Ilyarachna* species, but does not include the type species for the genus *I. longicornis*. It is upheld by a single character, cephalon dorsally with robust/stout setae (usually scattered). Clade 33, which includes everything in clade 32 except for *Ilyarachna plana* Thitle, 1980 is upheld by the synapomorphy of pereonites 1–4 anterior margins with robust setae. Clade 46 consists of three *Ilyarachna* species and does include the type species *I. longicornis*. This clade is defined by the single character of pereonite 6 dorsally encroaching into at least half of pereonite 5.

3.6 Discussion

3.6.1 *Aspidarachna*

Aspidarachna was most recently revised by Kussakin (2003) who transferred *I. glabra* into *Aspidarachna*. However, this species does not align itself with the other two representatives of this genus in the present study. Illustrations of the type material of *A. glabra* by Birstein (1971) show that it has an uniramous uropod and that pereonites 1–4 are not compact. These characters are inconsistent with *Aspidarachna*'s definition as proposed by Sars (1897b). It is these characters which have resulted in *A. glabra* not aligning itself with the type species, and therefore rendering *Aspidarachna* paraphyletic.

As *A. glabra* is well separated from the type of *Aspidarachna*, *A. clypeata* in this analysis, it is considered *incertae sedis*, until an opportunity arises where it can be re-illustrated and redescribed and its generic placement resolved. With the removal of *A. glabra* from *Aspidarachna*, the genus is now monophyletic.

This analysis shows *A. glabra* to be the sister species to the new genus, *Epikopais* (clade 6, Fig. 3.4). In this analysis, the relationship between *Epikopais* and *A. glabra* is doubtful and has been influenced by impossible character states assumed for *Epikopais* by PAUP. PAUP does not distinguish between an unknown character state ('?') and an inapplicable character ('-') in a dataset and will assign a character state which will give the most parsimonious result (Hennig 1950; Swofford and Begle 1993). This can yield false cladograms, presenting assumed relationships based on impossible character states (Kitching *et al*. 1998). Two of the characters supporting this clade concern the mandibular palp. These characters are inapplicable to *Epikopais* as this genus lacks a mandibular palp.

The trichotomy which includes *Aspidarachna*, the *A. glabra–Epikopais* clade and *Pseudarachna* is dubious, since three of the four defining character states are not applicable to all the included genera. The relationship is not supported by a high bootstrap value (bootstrap support is less then 50) and is only supported by one character which is applicable to all included species: mandible, lacinia mobilis absent. The lacinia mobilis, however, has also been independently lost before on two separate occasions within the *Ilyarachna*-group, and thus this character alone is not reliable enough to consider the presented relationship plausible.

3.6.2 *Bathybadistes*

Bathybadistes is a monophyletic and well-supported clade, being the sister group to *Nyctobadistes*. *Nyctobadistes* is not included in *Bathybadistes* as this genus does not have the synapomorphic characters which define *Bathybadistes*.

In the past, the species included in *Bathybadistes* have been shrouded with uncertainty. Hessler and Thistle (1975) had reservations on their inclusion

of three species (although they did not discuss why): *Ilyarachna scabra* Birstein, 1971; *Ilyarachna tuberculata* Birstein, 1971; and *Ilyarachna venusta* Birstein, 1971. In his review of the Munnopsidae, Kussakin (2003) synonymised *Bathybadistes* in part with *Ilyarachna* and in part with *Echinozone*, reassigning *B. scabra*, *B. tuberculata*, *B. venusta* and *Bathybadistes longipes* (Birstein, 1963) to *Echinozone*, and another species, *Bathybadistes spinosissima* (Hansen, 1916) to *Ilyarachna*. Kussakin (2003) was correct to remove Birstein's four species from *Bathybadistes*, but the results from this analysis rejects the inclusion of *B. spinosissima* with *Ilyarachna* and confirms it place in *Bathybadistes*.

3.6.3 *Echinozone*

In the past, *Echinozone* has been a 'dumping ground' for those species which lack a mandibular palp (excluding those species of *Pseudarachna*). Merrin (2004b) transferred several species of *Echinozone* to the previously synonymised *Notopais*, and the present results confirm that these two genera are monophyletic and distinct.

The results presented here do not support Kussakin's (2003) placement of Birstein's four previously considered *Bathybadistes*, as they do not align with the type species, *E. coronata*. Along with *E. trispinosa* these five species form a well supported clade (clade 20; 97) and this clade is defined by many synapomorphies. This clade does form the basis of a new genus, however the material required for redescription and for the formulation of this new genus is from the north Pacific and proved too difficult to obtain from the Russian institutions that hold them. As this genus does not fit into the context of this thesis it will be described at a later date and not in this thesis. For now, this clade will be referred to as 'Group A' and the species are now considered as *incertae sedis*.

3.6.4 *Ilyarachna*

The results presented here show that *Ilyarachna* as presently constituted is evidently not a monophyletic genus, with species being widely spread over

three separate clades: clade 10, 32 and 46. Clades 32 and 46 both contain only *Ilyarachna* species, while clade 10 contains representatives from many genera.

Clade 10 is supported by three homoplasious characters and many of the relationships within clade 10 are doubtful, as they are influenced by missing data, in particular, inapplicable characters. While the relationships within *Notopais*, *Bathybadistes* and 'Group A' are robust, it is the relationships that these genera have with the *Ilyarachna* species which are doubtful. For instance, clade 12 is supported by a homoplasious character concerning spines on pereonite 5 and two characters concerning the mandibular palp. But these latter two characters are inapplicable to *Notopais* and 'Group A' as they lack a mandibular palp.

Ilyarachna zachsi Gurjanova, 1933 aligns with *Notopais* on the basis of possessing a horn-like spine on antenna 2 article 1. Although *I. zachsi* and *Notopais* share this character state, *I. zachsi* lacks the other distinguishing characters which define *Notopais* and therefore is not included in the genus.

It is possible that within clade 10, the species of *Ilyarachna* are eluding to something further, but from the results presented here, no clear conclusions can be made.

Clades 32 and 46 contain only *Ilyarachna* species, and the type species, *I. longicornis* is in clade 46. Clade 32 is defined by one character, cephalon with robust setae. This character is not stable, and the number of robust setae on the cephalon can vary within a single species, including being completely absent (Wolff 1962), and therefore I do not regard the character of sufficient merit to uphold a genus. This character is also inconsistent within this clade as robust setae are not present on the cephalon in all species. For example, *Ilyarachna franki* n. sp. has a pair of spines on the cephalon instead of setae. The other *Ilyarachna* group, clade 46, is not defined by any unique synapomorphies, but instead is supported by a single homoplasious character which is pereonite 6 dorsally encroaching into at least half of pereonite 5.

The three-way split of *Ilyarachna* indicates that there is taxonomic separation within the genus, but the present analysis suggests no unequivocal synapomorphies. Therefore, I do not feel confident to define these groupings as

separate genera based on the current data, and thus all species are retained in *Ilyarachna*.

3.7 Conclusions

Phylogenetic relationships within the *Ilyarachna*-group are still unclear. At the generic level, *Bathybadistes*, *Notopais*, *Pseudarachna*, *Epikopais* and *Nyctobadistes* are all well defined, monophyletic genera. *Aspidarachna*, *Echinozone* and *Ilyarachna*, however, are not monophyletic with *Ilyarachna* splitting three ways.

At a species level, this analysis does give, in part, a good understanding of relationships between species, but it does have some shortcomings. Although there are species which are well described and the type material is in good condition, many species have varying amounts of missing data. This missing data, either in the form of unknown character states or inapplicable characters, have affected the topology of the tree and the placement of these species. Better-quality material and descriptions will enable us to include more potentially informative morphological characters. The inclusion of characters which are only applicable to some species are useful in assessing the relationships between these species (for example, mandibular palp characters within *Ilyarachna*) but programs such as PAUP* need to have algorithms which can deal with this type of data effectively to enable a more plausible conclusion of relationships.

Chapter 4: A taxonomic revision of the *Ilyarachna*-group

Prior to this study, the *Ilyarachna*-group consisted of five genera, *Aspidarachna*, *Bathybadistes*, *Echinozone*, *Ilyarachna* and *Pseudarachna*, and included 56 species. During the course of this study, *Notopais* was taken out of synonomy (see Merrin 2004b) and two new genera have been described, *Epikopais* n. gen. and *Nyctobadistes* n. gen. Of the eight genera, six (*Bathybadistes*, *Epikopais* n. gen., *Ilyarachna*, *Notopais*, *Nyctobadistes* n. gen., and *Pseudarachna*) have new species that are described in this chapter. In total, this chapter describes 25 new species (including three species which have been published through the course of this study) and redescriptions of three known species, with the material coming from Antarctica, south-east Australia and New Zealand.

4.1 Material and Methods

The species of the *Ilyarachna*-group considered in this study have come primarily from collections from the south-west Pacific, namely from New Zealand's Exclusive Economic Zone (EEZ) collected by the National Institute of Water and Atmospheric Research (NIWA) and the Tasman Sea, collected by the Australian Museum (AM) and Museum Victoria (NMV; Fig. 4.1). These specimens have been collected at depths as shallow as 45 metres from off Bass Point (New South Wales, Australia) to 4405 metres from the Bellona Trough (Tasman Sea). These collections represent 37 putative species, a significant increase from the previously known species from the region. Twenty-five new species will be described in this study due with the rest of the material not adequate for descriptive purposes.

4.1.1 Dissection and illustration of specimens

Type material was selected on the quality of the material, with the most intact specimen chosen as the holotype. Dissection of holotypes was always

minimized; whenever possible the appendages were taken from a matched topotypic paratype. Specimens of this group of genera are brittle, and are rarely found complete in collections, consequently descriptions are composed from multiple specimens. Figure captions indicate which specimens were used.

Whole specimen drawings were made using a Zeiss Stemi SV11 dissecting microscope. Appendages were dissected and mounted onto glass slides in glycerine and illustrated using either a Nikon Optiphot-2 or a Nikon Labophot-2 compound microscope. All microscopes were fitted with a camera lucida.

Descriptions were prepared in the computer program DEscriptive LAnguage for TAxonomists (DELTA; Dallwitz *et al.* 1997). Measurements of whole animals were made under the dissecting microscope with a ruler. For ratios, length of the whole animal was taken from its lateral view, and its width from its dorsal view. Unless otherwise stated in text, all ratios of appendages and segments were calculated using the maximum lengths and widths. Directional information regarding pereopods follows Brusca *et al.* (1995). Figure plates were either hand-inked and lettered in Adobe Photoshop Elements, or electronically inked in Adobe Illustrator following the instructions of Coleman (2003) and Poore (pers. comm.).

Preserved specimens used for scanning electron microscopy (SEM), were put through the dehydration series as specified in Felgenhauer (1987). Specimens were then air dried and mounted onto SEM stubs, with whole specimens mounted onto a entomological pin with superglue first to allow for better orientation for microscopy. Stubs were then sputter coated with gold and examined under a Leica S440 scanning electron microscope.

Species names used in this thesis have either been published during the course of this work, or are names that will be given to the respective species when published. In these cases, although these names are not yet available, every effort has been made to follow ICZN rules and recommendations.

4.1.2 Abbreviations

Abbreviations used in text are as follows: PNS – penicillate seta/ae; RS – robust seta/ae; SS – simple seta/ae; SRS –sensillate robust seta/ae; SEM–

Scanning Electron Microscope; NSW – New South Wales; Tas – Tasmania; Vic – Victoria; AM – Australian Museum, Sydney; BMNH – The Natural History Museum, London; NIWA – National Institute of Water and Atmospheric Research, Wellington; NMV – Museum Victoria, Melbourne; WHOI – Woods Hole Oceanographic Institution; ZMHB – Museum für Naturkunde der Humboldt-Universität, Berlin.

4.2 Taxonomy

LIPOMERIDAE Tattersall 1905a

Ilyarachna-group

Diagnosis. Frontal arch broad and flat; clypeus with small median arch; cephalon trapezoid, wider posteriorly. Mandible calcareous, incisor process large, rounded with no defined cusps, rounded, molar triangular, not broad and truncate. Ambulatory pereopod 3–4 bases length near width and much shorter than pereopod 2 basis; pereopods 5–6 with carpus and propodus expanded, flat, propodus not as expanded as carpus; at least ischium superior margin, both margins of carpus and propodus inferior margin with row of plumose setae; pereopod 7 with plumose setae generally similar to that of pereopods 5–6, carpus and propodus not as expanded as seen in pereopods 5–6. Pleon triangular in dorsal view, with domed medial keel. Male pleopod 1 distal horns with fringe of fine SS on mesial margins. Operculum vaulted, with prominent medial keel. Pleopod 4 exopod slender, shorter than endopod, margins with fringe of fine SS. Pleopod 5 simple lobe. Uropodal protopod, small, flattened, leaf-like; uropodal ramus/rami inserted distolaterally on protopod.

Remarks. The *Ilyarachna*-group can be distinguished from other species groups in the Lipomeridae by the combination of the following characters: frontal arch broad and flat; clypeus with small arch just in centre; cephalon trapezoid, wider posteriorly; mandible incisor process large, rounded with no defined cusps;

ambulatory pereopod bases 3–4 length near width and much shorter than pereopod 2 basis; pereopod 7 carpus and propodus slender, setation similar to that of pereopods 5 and 6; operculum vaulted, with prominent medial keel; and uropodal protopod, flattened, leaf-like.

This group consists of six previously described genera (previously housed in the Ilyarachninae): *Aspidarachna*, *Bathybadistes*, *Echinozone*, *Ilyarachna*, *Notopais*, *Pseudarachna, Epikopais* n. gen., *Nyctobadistes* n. gen. and a monophyletic northern Pacific group identified as 'Group A' in Chapter 3, which will be described as a new genus, but separately as it does not fit into the context of this thesis. Refer to Table 4.1 for revised generic composition.

Key to the genera of the *Ilyarachna*-group

1. – Mandibles without palp…… 2
   – Mandibles with palp……..6

2. – Frons semi-circular; pereonite 2 largest; pereopod 2 large and robust, longer than pereopods 3 and 4, with short ischium; pereopods 5 and 6 carpus and propodus poorly developed …….*Pseudarachna* Sars, 1897b
   – Frons not semi-circular; pereonite 2 not largest; pereopod 2 ambulatory, similar or smaller to pereopods 3 and 4, never large and robust, ischium long; pereopods 5 and 6 carpus and propodus expanded ……..3

3. – Pereonite 5 anterior half narrowing to an elongate 'neck'; pereonites 5–7 somewhat reduced, lateral margins narrowing, margins distinct from each other …….. ……. 'Group A'
   – Pereonite 5 anterior half wide, not elongate and not forming a neck; pereonites 5–7 not reduced, lateral margins not so narrow, pereonites 'fit' into each other …….……....4

4. – Pereonites 1–4 without spines or robust setae……*Epikopais* n. gen.
   – Pereonites 1–4 with spines or robust setae…….…….5

5. – Pereonites with spines or robust setae; if pereonites with spines, all with an apical robust seta; antenna 2 article 1 with 'bull horn' type spine topped with a robust seta; mouthparts *in situ* appear almost horizontal in lateral view…… *Notopais* Hodgson, 1910
   – Pereonites never with robust setae, only spines; pereonite spines never with apical robust setae; antenna 2 article 1 more compact, spine much shorter; maxillipeds and frontal arch meet at an acute angle in lateral view ……. *Echinozone* Sars, 1897b

6. Pereonites 5–7 lateral margins narrow, pereonites do not 'fit' into each other; natasome somewhat reduced……..7
   – Pereonites 5–7 lateral margins not narrow, pereonites 'fit' into each other, natasome not reduced……..…...8

7. – Dorsal body spines with apical seta; pereonites 5–7 lateral margins either jagged or elongate, similar to a single spine; anterolateral margins of pleon with spine …….*Bathybadistes* Hessler and Thistle, 1975
   – Dorsal body spines with no apical seta; pereonites 5–7 lateral margins rounded, never jagged or elongate, similar to a single spine; anterolateral margin of pleon rounded, with no spine …….. *Nyctobadistes* n. gen.

8. – Pereonites 1–4 compact, smaller than pereonites 5–7; lacinia mobilis absent, mandibular molar small, conical; uropods biramous……. …….*Aspidarachna* Sars, 1897b
   – Pereonites 1–4 not compact, but still smaller than pereonites 5–7; lacinia mobilis present on left mandible; uropods generally uniramous, if biramous, exopod rudimentary and often fused…… *Ilyarachna* Sars, 1870

***Aspidarachna* Sars, 1897**

Aspidarachna Sars, 1897b: 140–141.— Kussakin, 2003: 239–240.

Type species. *Ilyarachna clypeata* Sars, 1870, by monotypy.

Diagnosis. Cephalic frons narrow, with defined ridge around antennae, almost meeting mandibles; cephalic anterior flanges absent, instead with even ridge. Pereonites 1–4 short, compact, spines absent; pereonites 5–7 lateral margins not narrow, natasome not reduced. Anterolateral margin of pleon without spine. Antennae positioned closely together; antenna 1 not small, distally with 2 rounded points, article 1 lateral flange absent; antennae 2 article 1 with no anterolateral spine. Mandible lacinia mobilis and spine row absent; palp present; mandibular fossa angular, sub-horizontal across mandible. Pereopod 2 ambulatory, not enlarged, ischium elongate; pereopods 5 and 6 carpus discoid; dactyli of natatory pereopods narrowing distally. Pleopod 4 exopod with more than 1 plumose seta. Uropods biramous with well-defined exopod.

Species included. *Aspidarachna clypeata* (Sars, 1870); *Aspidarachna carinata* (Birstein, 1963); and *Aspidarachna sekhari* (George and Menzies, 1968b).

Species excluded. *Aspidarachna glabra* (Birstein, 1971), now *incertae sedis*.

Remarks. *Aspidarachna* is distinguished from the other genera in the *Ilyarachna*-group by compact pereonites 1–4, the absence of anterior cephalic flanges, narrow cephalic frons and a defined ridge around the antennae. The frons are so narrow, that ventrally, the ridge around the antennae almost touches labrum and mandibles.

Aspidarachna sekhari is included in *Aspidarachna* with reservation as it is not well described. The illustrated shape of the cephalon is unusual, as it is elongate and nearly the length of the first four pereonites together. This shape could possibly be the result of the specimen being squashed under a microscope cover slip, but as the holotype has not been studied during the course of this study, this is only conjecture. It is also unclear from the illustration if the unique cephalic characters defined for *Aspidarachna* are present. Its inclusion in *Aspidarachna* is based on the illustrated mandible, as it matches the mandibular characteristics of the genus.

The taxonomic placement of *A. glabra* is uncertain and it here regarded as *incertae sedis*. It has a uniramous uropod rather than the diagnostic biramous uropod and the illustrations of the cephalon (Birstein 1971) are not sufficiently detailed enoughto determine the distinguishing cephalic characters of *Aspidarachna*. Redescription of this species is required to determine its correct generic position.

Aspidarachna is known from the North Atlantic and the northern Pacific oceans, from between 220–5495 metres.

Bathybadistes Hessler and Thistle, 1975

Bathybadistes Hessler and Thistle, 1975: 163.

Type species. *Bathybadistes hoplitis* Hessler and Thistle, 1975, by original designation.

Diagnosis. Cephalic frons wide, rectangular; anterior cephalic flanges present, small. Pereonites 1–4 with spines, each topped with an apical seta; pereonites 5–7 lateral margins narrow, either with elongate spine-like extensions or jagged; natasome somewhat reduced. Pleon anterolateral margin with spine. Antennae positioned closely together; antenna 1 not small, article 1 lateral flange absent, distally with 2 rounded points; antenna 2 article 1 with short distolateral spine topped with robust seta. Mandible lacinia mobilis reduced; spine row and mandibular palp both present, mandibular fossa angular, sub-horizontal across mandible. Pereopod 2 ambulatory; not enlarged; pereopods 5 and 6 carpus paddle shaped; dactyli of natatory pereopods narrowing distally. Pleopod 4 exopod with more than 1 plumose seta. Uropod biramous, exopod rudimentary.

Species included: *Bathybadistes andrewsi* n. sp.; *B. fragilis* Merrin, Malyutina and Brandt, submitted; *B. gurjanovae* (Menzies, 1962); *B. hoplitis* Hessler and Thistle, 1975; *B. multispinosa* (Menzies, 1962); and *B. spinosissima* (Hansen, 1916).

Remarks. *Bathybadistes* can be distinguished from other *Ilyarachna* group genera by: pereonites dorsally with spines, each possessing an apical seta (referred to as a pedestal setae by Hessler and Thistle [1975]); pereonites 5–7 with narrow lateral margins, distinct from each other, either with elongate extensions or jagged, natasome somewhat reduced; anterolateral margin of the pleon with a spine; and uropod with rudimentary exopod.

The dorsal spines of *Bathybadistes*, each with a distal seta, are similar to those that are found in many species of *Notopais* Hodgson, 1910, however *Notopais* does not have a mandibular palp and lacks the reduction of the posterior three pereonites as seen in *Bathybadistes*. The pattern of spines found on the lateral margins of the posterior three pereonites is unique in the *Ilyarachna* group, although the elongate spine-like lateral margin is not unique within the munnopsid clade of Asellota as it is displayed by many other genera, e.g. those in the Acanthocopidae.

Bathybadistes is known from the south-west Pacific, Antarctica (Weddell Sea), and the Atlantic Ocean and is found at depths between 2700 and 5024 metres.

***Bathybadistes andrewsi* n. sp. (Figs 4.2–4.5)**

Material examined.— Holotype. Male (4.0 mm), Bellona Trough, Tasman Sea, stn P937, 41°19.2'S, 166°27.9'E, 21 April 1980, epibenthic sled, 3253–3347 m, RV *Tangaroa* (NIWA XXXX). Paratypes. 5 males (dissected paratype 3.5 mm; 1 specimen 4 mm, dissected for SEM), 6 females (dissected paratype 5.0 mm; 1 specimen, 4 mm for SEM), 3 fragments, type locality (2 fragments, 2 mm and 1 mm, for SEM; NIWA XXXX).

Description. *Male*. Body about 2.5 times as long as width of pereonite 2 (from spine tip to spine tip); widest at pereonite 5; cuticle calcified, granular. Cephalon with 6 dorsal and 8 lateral spines; posterolateral margins broadly rounded. Pereonite 1dorsally with 2 large and 2 small spines, pereonite 2 with 2 large and 4 small 4 spines, pereonite 3 with 4 large spines, pereonite 4 with 2

large and 4 small dorsal spines. Lateral margins of pereonite 2 and 3 with pairs of small spines. Anterolateral margins of pereonites 1–3 smooth, pereonite 4 with pair of small lobes. Coxae of pereopods 1 and 2 each with spine. Pereonite 5 anterior margin smooth; posterior margin with dorsal pair of spines; anterolateral margin rounded. Pereonites 5–7 lateral margins with posterior facing narrow spine-like extensions; dorsally each with pair of spines, pereonites 5–6 with additional pair of tubercles. Pereonite 7 ventrally with 2 spines on central swelling between pereopods. Pleon 1.4 times as long as proximal width, anterior two-thirds rounded, swollen, with 4 small dorsal spines, distal third triangular, somewhat flattened, coming to a narrow dorsally directed posterior tip.

Antenna 1 of 22 articles; article 1 ratios similar to female, distomesial margin with 1 PNS and 1 SRS, surface with 2 PNS, lateral margin with 5 SRS and 1 PNS; article 2 2.2 times as long as wide; distal margin with 1 PNS; article 4 mesial margin with 1 PNS; from article 9 onwards, each article has 1 aesthetasc; terminal article with 1 aesthetasc and 1 SS.

Pleopod 1 3.6 times as long as proximal width, lateral margins indent 0.5 from proximal end, either side of central margin with 6 setae (4 SRS and 2 SS + 3 SRS and 3 SS), distally with 31 SS (15 + 16 — both sides with 3 SS on distal surface) Pleopod 2 protopod 3.3 times as long as wide, lateral margin with 3 SS (on proximal half) and 6 plumose setae, surface with 2 plumose setae, mesial margin with 6 plumose setae, 1 SS and many fine SS, distally with lamellar extension; exopod elongate, 0.2 times as long as protopod; stylet 0.6 times as long as protopod, terminating to a point; sperm duct 0.5 times as long as stylet.

Female. Antenna 1 of 9 articles; article 1 1.4 times as long as wide, mesial margin with 2 distal SRS, surface with 3 PNS, lateral margin with 4 SRS and 2 SS; article 2 elongate, 0.5 times as long article 1, and 3.6 times as long as wide, distomesial margin with 1 PNS; article 3 mesial margin with 1 SS; article 4 mesial margin with 2 PNS; article 6 lateral margin with 1 SS; article 8 with an aesthetasc; terminal article with 1 aesthetasc and 2 SS.

Antenna 2 damaged; articles 1–3 more or less triangular; article 2 0.9 times as long as article 1, with spine similar to article 1; article 3 1.5 times as

long as article 1, scale with 2 RS; article 4 small, 1.1 times as long as article 1, with no ornamentation

Mandible without cuticular scales; left lacinia mobilis reduced and smooth, truncate; spine row with 7 spines; molar large, distally with 1 SS and 4 bi-serrate setae; mandibular palp short, not extending beyond incisor, article 1 with 5 SS (on left mandible, 1 SS on right), article 3 with 2 SS (1 long and 1 short). Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.8 times as wide as mesial lobe, distal margin with few fine SS and 7 RS, 2 dentate RS and 3 pectinate RS; mesial lobe distally with 6 SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long PS; middle lobe 1.4 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.6 times as wide as lateral lobe, margins and surface with fine SS, terminally with 8 blunted SS, 8 toothed setae and 1 long pectinate setae. Maxilliped coxa square, as long as wide, and 0.4 times as long as basis (including endite); basis elongate, 3.0 times as long as wide (including endite); endite with 5 coupling hooks, distally with 4 SS, 2 toothed setae, 6 fan setae (distomesial one longest) and many fine SS; palp article 1 0.3 times as long as basal endite, rectangular, distomesial margin with small lobe and 1 SS; article 2 3.4 times as long as, and 1.2 times as wide as article 1, and 1.6 times as wide as basal endite, lateral margin with 4 SS, mesial margin with 5 distally pappose setae; article 3 1.6 times as long as, and 0.9 times as wide as article 1, with 1 SS on lateral margin, mesial margin with 3 SS and 6 distally pappose setae; articles 4 and 5 rectangular; article 4 1.1 times as long as, and 0.4 as wide as article 1, lateral margin with 1 SS, distal margin with 1 SS and 1 distally pappose seta; article 5 shortest, 0.9 times as long as, and 0.2 times as wide as article 1, with 5 terminal distally pappose setae; epipod 1.7 times as long as wide, and 1.1 times as long as basis, margins with cuticular scales and few scattered SS, surface with 1 SS.

Pereopod 1 basis 5.8 times as long as wide, inferior margin with 11 evenly spread SS and 1 long SS at mid-point, distal margin with 2 SRS, superior margin with 19 SS and 4 RS; ischium 3.6 times as long as wide, inferior margin with 4 SS (1 at mid-point, 3 in clump on distal margin), lateral surface with 4 SS, superior margin with 2 SRS and 4 SS; merus 1.3 times as long as wide, inferior

margin with 13 SS, distosuperior margin with 2 SRS and 5 SS; carpus 4.3 times as long as wide, inferior margin with 19 SS (lengths varying), superior margin with 8 SS (3 in clump on distal margin); propodus 6.2 times as long as wide, inferior margin with 12 SS, lateral surface with 2 SS, superior margin with 2 SS; dactylus 3.2 times as long as proximal width, superior margin with 3 SS (in distal clump).

Pereopod 5 basis 3.9 times as long as wide, inferior margin with 3 SS and 3 PNS, superior margin with 17 SS; ischium 3.0 times as long as wide, inferior margin with 9 SS, lateral surface with 3 SS; merus 1.1 times as long as wide, inferior margin with 6 SS and 6 RS, lateral surface with 3 small SS, distosuperior margin with 3 SS; carpus 1.5 times as long as wide, inferior margin with 4 SS, distosuperior margin with 1 SRS; propodus elongate, 4.7 times as long as wide, distoinferior corner with 1 SS, plumose setae on this margin are weakly plumose, superior margin with 14 SS (of which 3 are sub-marginal), distosuperior margin with 1 PNS; dactylus 5.6 times as long as proximal width, with 5 SS (4 in clump in distal half).

Pereopod 7 basis 5.5 times as long as wide, inferior margin with 21 long SS, superior margin with 2 SS; ischium 4.0 times as long as wide, inferior margin with 14 SS, superior margin with 6 weakly plumose setae and 1 SS; merus 1.5 times as long as wide, inferior margin with 7 SS, distosuperior margin with 2 SS; carpus 5.1 times as long as wide, inferior margin with 6 SS, lateral surface with 1 SS, superior margin with 1 SS, distally with 1 RS, plumose setae on carpus are sparsely plumose; propodus 9.0 times as long as wide, distoinferior margin with 2 SS, lateral surface with 7 small scattered SS, distosuperior margin with 3 SS and 1 PNS; dactylus 8.6 times as long as proximal width, superior margin with 3 SS and inferior margin with 2 SS.

Operculum 2.3 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with row of RS, distal surface with 4 plumose setae (at least, 3 are broken) and few scattered SS, lateral margins with numerous plumose setae and 3 proximolateral SS (each side). Pleopod 3 exopod, 1.5 times as long as endopod, laterally with row of fine SS, distally with 7 long plumose setae and 1 sub-marginal SS; endopod 2.6 times

as long as wide, with 3 long plumose setae. Pleopod 4 exopod distally with 3 terminal long plumose setae; endopod oval, 1.7 times as long as wide. Pleopod 5 1.8 times as long as wide.

Uropod protopod 2.3 times as long as wide, sub-triangular, distal end rounded, lateral margin with 10 plumose setae, 6 SS and 2 RS at most distal point, mesial margin with 1 plumose seta, surface with 1 plumose seta; exopod rudimentary, with 3 SS; endopod 0.2 times as long as protopod, with 3 SS and 6 PNS.

Remarks. *Bathybadistes andrewsi* n. sp. is most similar to *Bathybadistes fragilis* Merrin *et al*. (submitted) from the Weddell Sea, and these two species are easily distinguished from all other *Bathybadistes* by the spine-like lateral margins of pereonites 5–7 and the body with prominent dorsal spines. These two species share many similarities, such as a highly granular body surface; large prominent spines on the dorsal surface of the pereonites; narrow and elongate lateral margins of pereonites 5–7; and the distal tip of the pleon points upwards in both species. *B. andrewsi* can be distinguished from *B. fragilis* by: more spines on the cephalon and less spines pereonites 5–7 than in *B. fragilis*; antenna 1 article 1 has a less angular lateral margin and a different arrangement of setae; no penicillate setae on the basis of pereopod 7; and more long plumose setae on the exopods of pleonites 3 and 4.

Distribution. Known only from the type locality, the Bellona Trough, Tasman Sea, between 3253–3347 metres.

Etymology. For Neil Andrews, SEM technician at the University of Canterbury, in thanks and recognition of his assistance in taking the scanning electron micrographs.

***Echinozone* Sars, 1897**

Echinozone Sars, 1897b: 139.— Schultz, 1976: 2–4.— Kussakin, 2003: 245–246.

Type species. *Ilyarachna coronata* Sars, 1870, by monotypy.

Diagnosis. Cephalic frons elongate, trapezoid, without defined ridge around antennae; cephalon anterior flanges present, small; pereonites 1–4 not short or compact, dorsal spines present, without apical setae; pereonites 5–7 wide, lateral margins not narrow, natasome not reduced. Pleon anterolateral margins without spine. Antennae positioned closely together; antenna 1 not small, article 1 lateral flange absent; antennae 2 article 1 with no anterolateral spine. Mandible lacinia mobilis and spine row present; palp absent; mandibular fossa angular, sub-horizontal across mandible. Pereopod 2 ambulatory, not enlarged, ischium elongate; pereopods 5 and 6 carpus paddle-shaped; dactyli of natatory pereopods narrowing distally. Pleopod 4 exopod with 1 plumose seta. Uropods biramous with well defined exopod.

Species included. *Echinozone coronata* (Sars, 1870).

Species excluded. These species are regarded as *incertae sedis*: *Echinozone arctica* Hansen, 1916; *Echinozone bispinosa* Kussakin and Vasina, 1982; *Echinozone longipes* (Birstein, 1963); *Echinozone scabra* (Birstein, 1971); *Echinozone trispinosa* (Kussakin and Vasina, 1993); *Echinozone tuberculata* (Birstein, 1971); and *Echinozone venusta* (Birstein, 1971); *Echinozone aries* (Vanhöffen, 1914) is transferred to *Epikopais* n. gen.

Remarks. *Echinozone* can be distinguished from the other genera of the *Ilyarachna*-group by the elongate and trapezoid frons and presence of dorsal spines without apical setae. *E. coronata* is the only species that conforms with the original definition of *Echinozone* as proposed by Sars. *E. arctica* is excluded from *Echinozone* on the basis of the following characters: the left mandible is without a lacinia mobilis and the spine row is absent, these are present in *Echinozone*; the posterior three pereonites of *E. arctica* are somewhat reduced and are much smaller and narrower than those seen in *E. coronata*; and the length of the first four articles of antenna 2 are large in proportion to the cephalon. Hansen (1916) considered body shape to be unimportant in diagnosing the *Echinozone*, however, my analysis has shown that body shape, especially

concerning the shape of the natasome is important. He also commented that the first four articles of antenna 2 combined were the largest he had seen of any existing *Echinozone* and *Ilyarachna*. Apart from some whole body illustrations of *E. arctica* by Svavarsson (1988), this species has not been redescribed since its original description, and redescription of *E. arctica* would resolve its correct generic placement.

From the illustrations in Kussakin and Vasina (1982), *E. bispinosa* does not conform to the generic description of *Echinozone* as it has a uniramous uropod and from the illustrations this species can not be placed into any existing genus. *E. bispinosa*, is thus considered *incertae sedis* and requires redescription to resolve its generic placement. The five north Pacific species: *E. longipes*, *E. scarbra*, *E. trispinosa*, *E. tuberculata* and *E. venusta* neither resemble Sars' description of *Echinozone* nor align themselves with *E. coronata* when cladistically analysised. They form a monophyletic clade that forms the basis of a new genus which will be described at a later date (see previous chapter for discussion).

Echinozone is known from the North Atlantic between depths of 188–1505 metres.

***Epikopais* n. gen.**

Type species. Epikopais pilosus n. sp., here designated.

Diagnosis. Cephalic frons short, laterally rounded, with no defined ridge around antennae; cephalon anterior flanges present, may be large; pereonites 1–4 margins with simple setae, spines absent; pereonites 5–7 lateral margins not wide, natasome not reduced. Pleon anterolateral margin without spine. Antennae positioned closely together; antenna 1 not small, article 1 with 1 distal point, lateral flange absent; antenna 2 article 1 without anterolateral spine. Mandible spine row either present or absent; lacinia mobilis and palp both absent; mandibular fossa curved, along lateral margin of mandible. Pereopod 2 ambulatory, not enlarged; ischium elongate; carpus of pereopods 5 and 6 discoid;

dactyli of natatory pereopods narrowing distally. Pleopod 4 exopod with 1 plumose seta. Uropods biramous, with large exopod.

Species included. ***Epikopais aries*** (Vanhöffen, 1914) comb. nov.; ***Epikopais mystax*** n. sp.; ***Epikopais pilosus*** n. sp.; and ***Epikopais waringa*** n. sp.

Remarks. ***Epikopais*** n. gen. can be distinguished from the other genera in the *Ilyarachna*-group by having only simple setae on the anterior margins of pereonites 1–4 and the unique shape of the mandible and cephalic frons. The keel of the operculum is wide and may be bulbous, a shape not found in any other genus. The body of this genus is short, similar to *Echinozone* and not as streamlined and elongate as *Ilyarachna*. The only previously described species of this genus, ***E. aries*** was originally place in *Aspidarachna* and was then moved to *Echinozone* by Hessler and Thistle (1975). Examination of the type material shows that this species does not fit into the diagnoses to either *Aspidarachna* or *Echinozone* but does agree with the diagnosis of ***Epikopais*** and is therefore transferred.

Epikopais is known from Antarctica, south-western Australia and New Zealand, at depths of 385–1586 metres.

Etymology. ***Epikopais*** is derived from the Greek word epikopos, meaning furnished with oars, in reference to the natatory pereopods of these animals.

Key to the species of *Epikopais*

1. — Body not covered in setae; anterolateral cephalic flanges large; opercular keel wide, bulbous, not elongate……2
   — Body covered in setae; anterolateral cephalic flanges small; opercular keel elongate, not bulbous ……***Epikopais pilosus*** n. sp.

2. — Frons with elongate setae above labrum ……..3
   — Frons without elongate setae above labrum .....……
   …….…….....***Epikopais aries*** (Vanhöffen, 1914)

3. — Pereonites 5–7 together much longer than pereonites 1–4; pereonite 5 anterior margin with few setae; pereonite 7 anteriorly wide; operculum keel, wide, short, triangular ……..……*Epikopais waringa* n. sp.
   — Pereonites 5–7 together sub-equal with pereonites 1–4; pereonite 5 anterior margin with many setae; pereonite 7 anteriorly narrowing; opercular keel longer, not triangular…….*Epikopais mystax* n. sp.

***Epikopais mystax* n. sp. (Figs 4.6–4.7)**

Material examined.— All of South Island, New Zealand. Holotype. Female (3.0 mm), Bounty Trough, stn S151, 45°45.8'S, 174°30.5'E, epibenthic sled, 26 September 1979, 1586 m, RV *Tangaroa* (NIWA XXXX). Paratypes. Female (2.7 mm, dissected), Bounty Trough, stn S153, 45°21.1'S, 173°35.8'E, epibenthic sled, 27 September 1979, 1386 m, RV *Tangaroa* (NIWA XXXX). Female (undissected), type locality (NIWA XXXX).

Description. *Female*. Body about 2.1 times as long as greatest width of pereonite 2; widest at pereonite 5; cuticle not highly calcified. Cephalon cuticle smooth; posterolateral margins rounded, anterior cephalic flanges spine-like. Frons with long SS. Pereonites 1–5 anterior margins with SS; anterolateral margins of pereonites 3–4 with anteriorly facing lobes. Pereonite 6 and 7 ventrally without ornamentation. Pleon 0.7 times as long as proximal width, posterior tip rounded.

Antenna 1 damaged, not complete; article 1 elongate, 2.1 times as long as wide, distal end with narrow extension, surface with 2 PNS and 1 SS, distal margin with 5 SRS and 1 PNS; article 2 elongate, 0.4 times as long article 1, and 2.5 times as long as wide, distally with 4 SRS; article 4 with 1 PNS. Antenna 2 damaged, not complete; articles 1–3 more or less triangular; article 1 lateral margin with 1 SRS; article 2 1.0 times as long as article 1, distolateral margin with 3 SRS (1on ventral side); article 3 1.4 times as long as article 1, with 1 SRS,

scale with, 1 SS, mesial margin with 3 SRS; article 4 slightly elongate, 1.3 times as long as article 1, with 1 SS.

Mandible spine row with 3 spines; molar small, with 2 terminal uni-serrate setae. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.5 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 4 dentate RS, 4 pectinate RS, and 1 bi-serrate RS, mesial lobe distally with many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.0 times as wide as lateral lobe, margins with mesial and distal margins with fine SS, distally with 6 blunt SS, 3 toothed setae, and 1 long pectinate seta. Maxilliped coxa rectangular, 1.3 times as long as wide, and 0.3 times as long as basis (including endite), with 2 RS; basis elongate, 3.6 times as long as wide (including endite), with 4 RS; endite with 3 coupling hooks, 4 toothed setae, 4 fan setae and few fine SS; palp article 1 wide, short, 0.2 times as long as basal endite, cuticular scales present, distomesial margin with 1 RS; article 2 4.4 times as long as and 1.4 as wide as article 1, 0.9 times as wide as basal endite, with cuticular scales on lateral margin, distolateral margin with 1 RS, mesial margin with 3 distally pappose setae; article 3 2.3 times as long as and 0.8 times as wide as article 1, lateral margin with 1 RS, mesial margin with 2 SS and 7 distally pappose setae; article 4 0.9 times as long as and 0.4 as wide as article 1, with 2 distally pappose setae; article 5 narrow, 1.1 times as long as and 0.2 times as wide as article 1, lateral margin with 1 SS distally with 3 distally pappose setae and 1 SS; epipod 1.6 times as long as wide, 1.1 times as long as basis, margins with many cuticular scales.

Pereopod 1 basis missing; ischium 4.1 times as long as wide, inferior margin with 1 SS, lateral surface with 2 SRS (on opposable surface), superior margin with 2 RS; merus 1.0 times as long as wide, inferior margin with 3 SS, distosuperior margin with 2 SS; carpus 3.4 times as long as wide, inferior margin with 5 SS, superior margin with 1 SS; propodus 4.3 times as long as wide, inferior margin with 5 SS, superior margin with 2 SS; dactylus 3.8 times as long as proximal width, superior margin with 2 SS.

Operculum 2.1 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel with row of short, lightly plumose, proximally with 7 SS, distal surface with few scattered SS, lateral margins with numerous plumose setae, extending proximally towards keel. Pleopod 3 exopod, 1.4 times length of endopod, distally with 4 long plumose setae and 1 SS; endopod 1.4 times as long as wide, with 3 long plumose setae. Pleopod 4 endopod roughly circular, 1.2 times as long as wide. Pleopod 5 1.0 times as long as wide.

Uropod protopod 1.3 times as long as wide, distal end rounded, margins with cuticular scales, lateral margin with 2 plumose setae, distal margin with 4 SS and 2 plumose setae; exopod small, 0.4 times as long as protopod, 0.8 times as long as endopod, with 2 SS; endopod 0.6 times as long as protopod, with 5 PNS and 2 SS.

Males are not known from this species.

Remarks. *Epikopais mystax* n. sp. is distinguished from the other species of *Epikopais* by: the length of pereonites 1–4 being more elongate when compared to the natasome than seen in the other species of this genus; a row of simple setae along anterior margin of pereonite 5; and the frons with numerous long setae. *E. mystax* is most similar to *Epikopais waringa*, but differs on several features. *E. mystax* has many more elongate setae on the frons and the body is much narrower than in *E. waringa*. Pereonites 1–4 are more elongate in comparison to pereonites 5–7 in *E. mystax*, while in *E. waringa* pereonites 1–4 are shorter in comparison to pereonites 5–7. The operculum keel of *E. mystax* is more elongate and less triangular than in *E. waringa*.

Distribution. Bounty Trough, South Island, New Zealand, between 1386–1586 metres.

Etymology. Mystax is Greek, meaning hair on the upper lip, in reference to the many long setae present on the frons.

***Epikopais pilosus* n. sp. (Figs 4.8–4.12)**

Material examined.— All off south-eastern Australia. Holotype. Ovigerous female (2.4 mm), 44 km E of Nowra, NSW, stn SLOPE 56, 34°55.79–56.06'S, 151°08.06–07.86'E, 22 October 1988, WHOI epibenthic sled, 429–466 m, RV *Franklin*, muddy coarse shell (ex NMV J18844). Paratypes. 22 females, 21 males (1 male, 2.0 mm, dissected) 2 fragments, type locality (ex NMV J18844), 2 females (2.3 mm, dissected, 2.0 mm partially dissected), south of Point Hicks, Victoria, stn SLOPE 33, 38°19.60'S, 149°24.30'E, 23 July 1986, 930 m, WHOI epibenthic sled, RV *Franklin* (NMV J18845).
Additional material.— 8 females, 7 males, 5 fragments, south of Point Hicks, Victoria, stn SLOPE 40, 38°17.70'S, 149°11.30'E, 24 July 1986, WHOI epibenthic sled, 400 m, RV *Franklin*, coarse sand, gravel, mud (NMV J18843).

Description. Female. Body about 2.1 times as long as greatest width of pereonite 2; widest at pereonite 2; cuticle not highly calcified, setose. Cephalon with no spines; posterolateral margins rounded; anterior cephalic flanges small. Pereonites 1–4 anterior margins with few SS. Pereonite 5 anterior margin smooth; anterolateral margins of pereonites all rounded except pereonites 4, 6 and 7 which have small lobes; pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with pair of setae. Pleon 0.9 times as long as proximal width, posterior tip rounded, with scattered SS.

Female antenna 1 of 9 articles; article 1 elongate, 1.8 times as long as wide, mesial margin with 1 SRS and 4 SS, surface with 4 SS, 2 PNS and 1 SRS, lateral margin with 7 SS, distal margin with 5 SS and 1 PNS; article 2 elongate, 0.6 times as long article 1, and 2.5 times as long as wide, with 4 SRS and 1 PNS, distal extension with 2 PNS; article 3 with 1 SS; article 4 with 2 PNS; article 5 with 1 SS; from article 6, each article with 1 aesthetasc; terminal article with 1 PNS and 2 SS.

Mandible molar small, distally with 4 uni-serrate setae; socket-like structure with 1 SS at approximate place of mandibular palp. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.5 times as wide as mesial lobe,

distal margin with few fine SS, distal margin with 3 RS, 3 dentate RS and 6 pectinate RS, mesial lobe distally with many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.2 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.2 times as wide as lateral lobe, margins with fine SS, proximally mesial margin also with 8 elongate setae (unable to tell what type), distally with 3 blunt SS 4 toothed setae, 1 long pectinate seta and few fine SS. Maxilliped coxa rectangular, 0.9 times as long as wide, and 3.2 times as long as basis (including endite); basis elongate, 3.7 times as long as wide (including endite), with 5 SS, distolateral margin with 1 SS; endite with 4 coupling hooks, 2 toothed setae, 4 fan setae and few fine SS; palp article 1 sub-rectangular 0.3 times as long as basal endite, sub-rectangular, distolateral margin with 1 SS, distomesial margin with 1 SS; article 2 3.2 times as long as and 1.5 as wide as article 1, 2.2 times as wide as basal endite, with lateral margin with cuticular scales and 4 SS, surface with 6 SS, mesial margin with 2 distally pappose setae, and 2 SS; article 3 1.6 times as long as and 0.8 times as wide as article 1, lateral margin with 1 SS, mesial margin with 4 SS and 11 distally pappose setae; articles 4 and 5 sub-rectangular; article 4 0.7 times as long as and 0.3 as wide as article 1, mesial margin with 4 distally pappose setae; article 5 narrow, 0.6 times as long as and 0.2 times as wide as article 1, lateral margin with 1 SS, distally with 2 SS and 2 distally pappose setae; epipod 2.0 times as long as wide, 1.2 times as long as basis, margins with cuticular scales and surface with scattered SS.

Pereopod 1 basis 4.9 times as long as wide, lateral surface with 18 SS, superior margin with 16 SS; ischium 3.2 times as long as wide, inferior margin with 4 SS, lateral surface with 7 SS, superior margin with 4 SS and 1 RS; merus 0.9 times as long as wide, inferior margin with 3 SS and 5 RS, lateral surface with 1 SS, distosuperior margin with 2 SS; carpus 2.1 times as long as wide, inferior margin with 5 SS, superior margin with 4 SS; propodus 5.4 times as long as wide, inferior margin with 6 SS, lateral surface with 3 SS, superior margin with 4 SS; dactylus 3.4 times as long as proximal width, distosuperior margin with 3 small SS.

Pereopod 2 basis missing; ischium damaged, inferior margin with 18 SRS, lateral surface with 5 SRS and 36 SS; merus 1.7 times as long as wide, inferior margin with 10 SRS, lateral surface with 4 SS and 6 SRS, superior margin with 2 SRS, distosuperior margin with 2 SRS and 1 SS; carpus 5.1 times as long as wide, inferior margin with 17 SRS, lateral surface with 10 SRS and 4 SS, superior margin with 19 SRS and 1 PNS; propodus 8.0 times as long as wide, inferior margin with 8 SRS, lateral surface with 3 SRS and 2 SS, distal margin with 7 SS, superior margin with 1 PNS, 8 SRS and 7 SS; dactylus 4.5 times as long as proximal width, superior margin with 6 SS, inferior margin with 2 SS and 3 SRS.

Pereopod 3 basis 1.2 times as long as wide, inferior margin with 2 SRS and 7 SS, lateral surface with 15 SS, superior margin with 5 PNS and 5 SS; ischium 5.2 times as long as wide, inferior margin with 8 SRS and 3 SS, lateral surface with 55 SRS, superior margin with 14 SRS; merus 2.6 times as long as wide, inferior margin with 6 SRS, lateral surface with 5 SRS, distosuperior margin with 3 SRS; carpus 9.9 times as long as wide, inferior margin with 12 SRS, lateral surface with 11 SS, 1 PNS and 6 SRS, superior margin with 11 SRS; propodus damaged; dactylus absent.

Pereopod 4 basis 1.2 times as long as wide, inferior margin with 5 SRS and 2 SS, lateral surface with 6 SS, superior margin with 3 SRS and 6 SS, distally with 5 PNS; ischium 4.7 times as long as wide, inferior margin with 1 SS and 8 SRS, lateral surface with 4 SRS, superior margin with 9 SRS, distally with 11 SRS; merus 3.8 times as long as wide, inferior margin with 6 SRS, lateral surface with 2 SRS, superior margin with 7 SRS; carpus 10.6 times as long as wide, inferior margin with 17 SRS and 1 SS, lateral surface with 1 SS and 13 SRS, superior margin with 1 PNS, 14 SS and 18 SRS; propodus 12.4 times as long as wide, inferior margin with 14 SRS, lateral surface with 5 SS and 6 SRS, superior margin with 9 SS, 1 PNS and 10 SRS; dactylus 5.4 times as long as proximal width, inferior margin with 3 SRS and 4 SS, superior margin with 6 SS.

Pereopod 5 basis 3.4 times as long as wide, inferior margin with 11 SS, lateral surface with 9 SRS and 27 SS, superior margin with 5 PNS and 2 SS; ischium 2.2 times as long as wide, inferior margin with 7 SRS and 9 SS, lateral

surface with 14 SS; merus 1.2 times as long as wide, inferior margin with 7 SS, distosuperior margin with 1 short plumose setae; carpus 2.4 times as long as wide, distosuperior margin with 1 SS; propodus 2.4 times as long as wide, lateral surface with 12 SS, superior margin with 1 SRS and 1 PNS; dactylus 3.1 times as long as proximal width, with 4 SS.

Pereopod 6 basis 4.9 times as long as wide, inferior margin with 8 SS and 4 plumose setae, lateral surface with 4 plumose setae and 25 SS, superior margin with 1 SS and row of plumose setae; ischium 1.9 times as long as wide, inferior margin with 8 SRS and 4 SS, lateral surface with 12 SS and 3 SRS; merus 1.3 times as long as wide, inferior margin with 7 SS, lateral surface with 1 SS; carpus 1.2 times as long as wide, distosuperior margin with 1 SRS; propodus 3.1 times as long as wide, distoinferior margin with 2 SS, lateral surface with 7 SS, distosuperior margin with 1 SS and 1 PNS; dactylus 3.4 times as long as proximal width, inferior margin with 1 SS, lateral surface with 1 SS and superior margin with 2 SS.

Pereopod 7 basis 6.3 times as long as wide, inferior margin with 8 SS, lateral surface with 6 SS, superior margin with 8 SS; ischium 2.2 times as long as wide, inferior margin with 6 SS; merus 1.1 times as long as wide, inferior margin with 3 SS, distosuperior margin with 1 SS and 1 short plumose seta; carpus 2.3 times as long as wide, distosuperior margin with 1 SS; propodus 5.2 times as long as wide, distoinferior margin with SS, lateral surface with 4 short SS, distosuperior margin with 4 SS; dactylus 3.4 times as long as proximal width, with 4 SS (3 in distal clump).

Operculum 2.8 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with row of RS and SS, surface with scattered SS, margins anterolaterally with 4 SS (2 + 2), laterally with numerous plumose setae. Pleopod 3 exopod 1.3 times length of endopod, distally with 4 long plumose setae and 1 SS; endopod 1.5 times as long as wide with 6 long plumose setae. Pleopod 4 exopod with 1 terminal long plumose seta; endopod oval, 1.4 times as long as wide. Pleopod 5 1.8 times as long as wide.

Uropod protopod 1.7 times as long as wide, distal end rounded, lateral margin with 6 SS and 12 plumose setae, distal margin with 4 SS and 3 plumose

setae, surface with 13 scattered SS; exopod small, 0.2 times as long as protopod, 0.5 times as long as endopod with 2 SS; endopod 0.3 times as long as protopod, with 2 PNS and 3 SS.

Male. Antenna 1 of 28 articles; article 1 length 1.4 times width, lateral margin with 1 SS, surface with 1 PNS, distomesial corner with, 3 SRS and 1 PNS; article 2 1.7 times as long as wide and 0.6 times as long as article 1, distal margin with 3 SRS, distal extension with 3 PNS; article 3 with 1 SS; article 4 with 2 PNS; from article 6 onwards each article has 1 aesthetasc and many with additional setae; terminal article with 2 SS and 1 PNS. Antenna 2 article 1 missing, article 2 damaged, with 2 SS; article 3 with 3 SRS, scale with 3 RS; article 4 with no ornamentation; article 5 elongate, longer than articles 1–4, mesial margin with 12 SRS, surface with 9 RS, lateral margin with 13 SRS and 1 PNS, distal margin with 1 SRS; article 6 longer than article 5, mesial margin with 11 SRS, surface with 38 SRS, lateral margin with 15 SRS; flagellum of 31 articles, each setose.

Pleopod 1 4.2 times as long as proximal width, lateral margins indent 0.6 from proximal end, ventral surface with 45 setae (18 SS and 4 SRS + 19 SS and 4 SRS), distal lobes with 8 SS (5+3). Male pleopod 2 protopod 2.1 times as long as wide, lateral margin with 2 SS and row of plumose setae, surface with 6 SS distally with lamellar extension; exopod elongate and hooked, 0.1 times as long as protopod, with fine SS; stylet short, 0.4 times as long as protopod, terminating to a point; sperm duct 0.3 times as long as stylet.

Remarks. *Epikopais pilosus* n. sp. is distinguished from all other species in this genus by: body dorsally covered with setae; small anterolateral cephalic flanges; a small seta on the mandible in the approximate location of the palp; elongate operculum keel and an elongate uropodal protopod. *E. pilosus* is further distinguishable from *E. waringa* and *E. mystax* as this species does not have any elongate setae on the frons above the labrum and the endopod of pleopod 3 has many more plumose setae than found in the other two species.

Distribution. South-eastern Australia, from Nowra, NSW to south of Point Hicks, Victoria, from depths between 400–930 m.

Etymology. Pilosus (Latin, meaning hairy), in reference to the covering of dorsal body setae.

***Epikopais waringa* n. sp. (Figs 4.13–4.16)**

Material examined.— All material from south-eastern Australia. Holotype. Female (2.0 mm), off Freycinet Peninsula, Tas., stn SLOPE 47, 41°58.60'S, 148°38.80'E, 27 July 1986, WHOI epibenthic sled, 500 m, RV *Franklin*, coarse shell (ex NMV J18860). Paratypes. 1 female (2.0 mm), type locality, (ex NMV J18860). 1 male (1.5 mm, dissected), south of Point Hicks, Vic., stn SLOPE 34, 38°16.40'S, 149°27.60'E, 23 July 1986, WHOI epibenthic sled, 800 m RV *Franklin*, (NMV J18859)
Additional material.— 1 female, south of Point Hicks, Vic., stn SLOPE 32, 38°21.90'S, 149°20.0'E, 23 July 1986, WHOI epibenthic sled, 1000 m RV *Franklin* (NMV J18858).

Description. Female. Body 1.6 times as long as pereonite 2; widest at pereonite 5; cuticle not highly calcified, smooth. Cephalon cuticle smooth; anterior margins with few scattered setae; posterolateral margins rounded; anterior cephalic flanges spine-like. Pereonites 1–4 anterior margins with SS, pereonite 5 anterior margin smooth; anterolateral margins of pereonites all rounded except pereonites 3 and 4 which have small lobes; pereonites 6 and 7 ventrally with no ornamentation. Pleon 0.7 times as long as proximal width, posterior tip rounded, with scattered SS.

Antenna 1 of 8 articles; article 1 with distal extension, 1.8 times as long as wide, distal margin with 1 RS, 2 SS and 1 PNS, distal extension with 1 PNS; article 2 elongate, 0.5 times as long article 1, and 2.6 times as long as wide, distal margin with 2 PNS; article 4 with 2 PNS; from article 7, each article has 1 aesthetasc; terminal article with 1 SS and 1 aesthetasc.

Operculum 4.1 times as long as proximal width, medial keel wide, flat, rounded, with few lightly plumose setae and laterally with many fine SS, distal surface with 1 plumose setae, and few scattered SS, distally with medial

excision, margins anterolaterally margins with 5 sub-marginal SS (2+3), laterally with numerous plumose setae.

Male. Antenna 1 of 31 articles; article 1 1.6 times as long as wide, distal margin with 3 SRS, 1 PNS and 1 SS, distal extension with 1 SRS; article 2 1.6 times as long as wide, 0.5 times as long as article 1, distal margin with 2 PNS; article 3 with 1 SS; article 4 with 2 PNS; article 7 with 1 SS; from article 8 onwards, each article has 1 aesthetasc with many having additional SS; terminal article with 1 SS and 1 aesthetasc. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 lateral margin with 1 RS, surface with 2 SS; article 2 1.3 times as long as article 1, distolateral margin with 2 RS distally with 2 SS; article 3 1.4 times as long as article 1 with 2 SRS and 3 RS along distal rim, scale with 1 RS; article 4 small, 1.7 times as long as article 1, with no ornamentation.

Mandible spine row with 3 spines; molar small, with 2 terminal uni-serrate setae. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.5 times as wide as mesial lobe, distal margin with few fine SS, 10 RS and 2 dentate RS, mesial lobe distally with 3 SS, few fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 1.7 times as wide as lateral lobe, mesial and distal margins with fine SS, distally with 7 setae (unable to identify type) and 1 long pectinate seta. Maxilliped coxa rectangular, 1.7 times as long as wide, and 0.5 times as long as basis (including endite); basis elongate, 4.2 times as long as wide (including endite), with 1 SS; endite with 2 coupling hooks, 2 toothed setae, 4 fan setae and few fine SS; palp article 1 sub-rectangular, 0.3 times as long as basal endite, distomesial margin with 1 SS; article 2 4.2 times as long as, and 2.2 times as wide as article 1, 3.1 times as wide as basal endite, lateral margin with cuticular scales and 1 SS, mesial margin with 2 distally pappose setae and 1 SS; article 3 1.9 times as long as and 1.4 times as wide as article 1, lateral margin with 1 SS, mesial margin with 2 SS and 4 distally pappose setae; articles 4 and 5 rectangular; article 4 0.8 times as long as and 0.5 as wide as article 1, lateral margin with 1 SS and 2 distally pappose setae; article 5 narrow, 0.6 times as long as and 0.3 times as wide as article 1, with 2 SS and 2 distally pappose setae;

epipod 1.6 times as long as wide, 1.0 times as long as basis, margins with many cuticular scales.

Pereopod 1 basis 4.6 times as long as wide, inferior margin with cuticular scales, and 3 SS , superior margin with 2 SS and 1 PNS; ischium 3.5 times as long as wide, inferior margin with 1 SS and cuticular scales, superior margin with 1 SS; merus 1.3 times as long as wide, inferior margin with 3 SS, lateral surface with 1 SS, distosuperior margin with 2 SS; carpus 3.6 times as long as wide, inferior margin with 2 SS and cuticular scales, superior margin with 2 SS; propodus 4.9 times as long as wide, inferior margin with 5 SS (4 on distoinferior margin), distosuperior margin with 2 SS; dactylus 2.6 times as long as proximal width, distosuperior margin with 3 SS.

Pereopod 5 basis 3.0 times as long as wide, inferior margin with 3 SS, superior margin with 1 SRS, 2 PNS and 1 SS; ischium 1.8 times as long as wide, inferior margin with 2 SS, superior margin with 1 SS; merus 1.3 times as long as wide, inferior margin with 4 SS, distosuperior margin with 1 SS and 1 plumose seta; carpus 1.3 times as long as wide, lateral surface with 1 SS; propodus 2.5 times as long as wide, inferior margin with few plumose setae, lateral surface with 2 SS, distosuperior margin with 1 SRS and 1 PNS; dactylus 2.7 times as long as proximal width, with 4 small SS.

Pereopod 6 basis 3.7 times as long as wide, inferior margin with 7 SS and 1 PNS; ischium 1.9 times as long as wide, inferior margin with 3 SS; merus 1.4 times as long as wide, inferior margin with 3 SS, distosuperior margin with 1 SS and 1 plumose seta; carpus 1.1 times as long as wide; propodus 2.9 times as long as wide, inferior margin with few plumose setae, distally with 1 SS, superior margin with 2 RS and 1 PNS; dactylus 3.1 times as long as proximal width, with 4 small distal SS.

Pereopod 7 basis missing; ischium 2.9 times as long as wide, inferior margin with 5 SS; merus 1.3 times as long as wide, inferior margin with 2 SS, distosuperior margin with 1 plumose setae and 1 SS; carpus 1.7 times as long as wide, distosuperior margin with 1 SS; propodus 5.2 times as long as wide, inferior margin with few plumose setae, distosuperior margin with 1 SRS and 1

PNS; dactylus 7.1 times as long as proximal width, superior margin with 2 SS; unguis damaged.

Male pleopod 1 6.7 times as high as proximal height, central margin with 8 SS, distally with 7 SS. Male pleopod 2 protopod 2.2 times as long as wide, lateral margin with row of plumose setae, surface with 2 SS, distally with lamellar extension, mesial margin with 3 SS; exopod elongate, 0.2 times as long as protopod with fine SS; stylet long, hooked up into protopod, 2.5 times as long as protopod; sperm duct 0.8 times as long as stylet. Pleopod 3 exopod, 1.3 times length of endopod, distally with 4 long plumose setae and 1 SS; endopod 1.5 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 1 terminal long plumose setae; endopod oval, 1.3 times as long as wide. Pleopod 5 1.5 times as long as wide.

Uropod protopod 1.3 times as long as wide, distal end rounded, lateral margin provided with 3 plumose setae, distal margin with 1 plumose setae and 6 robust SS, mesial margin with 1 plumose setae, surface with 3 scattered SS; exopod large, 0.5 times as long as protopod, 0.7 times as long as endopod, with 2 SS; endopod large, 0.7 times as long as protopod, with 4 SS and 1 PNS.

Remarks. *Epikopais waringa* n. sp. is defined by: the wide body, which is about 0.7 times its length; anterior margins of pereonites 1–4 with few simple setae; and the triangular operculum keel. For further discussion please refer to the comments for *E. mystax*.

Distribution. South-eastern Australia, from Point Hicks, Victoria to Freycinet Peninsula, Tasmania, between 500 and 1000 metres.

Etymology. Waringa is an Aboriginal word meaning sea; noun in apposition.

Ilyarachna Sars, 1870

Mestostenus Sars, 1864: 211 (nom. preoccupp.).

Ilyarachna Sars, 1870: 44.— Sars, 1897: 134–135.— Hansen, 1916: 121–122.— Wolff, 1962: 94.— Birstein, 1971: 217–218.— Menzies and George, 1972: 9.76.—Thistle, 1980: 116–117.— Kussakin, 2003: 189–190.

Type species. *Mesostenus longicornis* Sars, 1864 by monotypy.

Diagnosis. Cephalic frons wide, rectangular; cephalic anterior flanges present, small. Pereonites 1–4 anterior margins either with spines or row of robust setae or smooth, if spines present, each topped with an apical seta; pereonites 5–7 lateral margins not narrow, more streamlined, natasome not reduced. Pleon in dorsal view longer than wide, with no anterolateral spine. Antennae positioned closely together; antenna 1 not small, article 1 lateral flange absent; antenna 2 article 1 with no spine (except *Ilyarachna zachsi*). Mandible lacinia mobilis present, reduced; spine row and mandibular palp both present; mandibular fossa angular, sub-horizontal across mandible. Pereopod 2 ambulatory, not enlarged, ischium elongate; pereopods 5 and 6 carpus discoid; dactyli of natatory pereopods narrowing distally. Pleopod 4 with more than one long plumose seta. Uropod uniramous or biramous, if biramous, exopod rudimentary, never large and articulating.

Species included. *Ilyarachna acarina* Menzies and Barnard, 1959; *Ilyarachna aculeatus* n. sp., *Ilyarachna affinis* Barnard, 1920; *Ilyarachna antarctica* Vanhöffen, 1914; *Ilyarachna armata* Thistle, 1980; *Ilyarachna australis* n. sp.; *Ilyarachna bergendali* Ohlin, 1901; *Ilyarachna bicornis* Hansen, 1916; *Ilyarachna calidus* George and Menzies, 1968b; *Ilyarachna calva* Pasternak, 1982; *Ilyarachna cheropin* n. sp.; *Ilyarachna crassiceps* Barnard, 1920; *Ilyarachna crozetensis* Kensley, 1980; *Ilyarachna crystallum* n. sp.; *Ilyarachna distincta* Birstein, 1971; *Ilyarachna dubia* Hansen, 1916; *Ilyarachna flindersi* n. sp.; *Ilyarachna frami* Just, 1980; *Ilyarachna franki* n. sp.; *Ilyarachna hirticeps* Sars, 1870; *Ilyarachna longicornis* (Sars, 1864); *Ilyarachna kermadecensis* Wolff, 1962; *Ilyarachna kurilensis* Kussakin and Mezhov, 1979; *Ilyarachna kussakini* Birstein, 1963; *Ilyarachna medorientalis* Chardy, 1974; *Ilyarachna moana* n. sp.; *Ilyarachna mokari* n. sp.; *Ilyarachna nordenstami* Wolff, 1962; *Ilyarachna pacifica* n. sp.; *Ilyarachna perarmata* Birstein, 1971; *Ilyarachna pervica* Menzies and George, 1972; *Ilyarachna plana* Thistle, 1980 *Ilyarachna polita* Bonnier, 1896; *Ilyarachna profunda* Schultz, 1966; *Ilyarachna propinqua*

Birstein, 1971; *Ilyarachna quorna* n. sp.; *Ilyarachna setosa* Kussakin, 1979; *Ilyarachna taranui* n. sp.; *Ilyarachna taratara* n. sp.; *Ilyarachna torleivi* Svavarsson, 1988; *Ilyarachna triangulata* Menzies, 1962; *Ilyarachna una* Thistle, 1980; *Ilyarachna vemae* Menzies and George, 1972; *Ilyarachna wolffi* Kensley, 1978; *Ilyarachna zachsi* Gurjanova, 1933.

Remarks. *Ilyarachna sensu lato* is recognised as a polyphyletic genus which is distinguished by the lack of several of the apomorphic characters which define the other genera.

The largest known diversity of *Ilyarachna sensu lato* is in the south-west Pacific with a total of 13 species. The results from the phylogenetic analysis show that *Ilyarachna sensu lato* can be split into three different groups on the basis of the marginal ornamentation of pereonites 1–4: margins with dorsal spines; margins with robust setae; or margins with no ornamentation. Within these groups, spiny *Ilyarachna* are only known from the Pacific Ocean. *Ilyarachna* species with marginal robust setae have two known areas of local radiation: New Zealand and south-east Australia; and the North Atlantic.

Many of the species *Ilyarachna* require redescription. Better and more complete data may contribute to an eventual resolution of the generic composition and clarify the definition of *Ilyarachna*

Ilyarachna sensu lato is found world wide between the depths of 8–7230 metres.

Key to the *Ilyarachna* species of Australia and New Zealand.

1. — Pereonites 1–4 anterior margins either with spines or only some margins with spines …… 2
   — Pereonites 1–4 anterior margins without spines, either smooth or with robust setae ……..……4

2. — Pereonites 1–4 anterior margins each with spines s; antenna 2 article 1 with many robust setae ……..……3

— Pereonites 2 and 4 anterior margins with spines, spines absent on pereonites 1 and 3; antenna 2 article 1 with single robust seta …..…..……. *Ilyarachna taranui* n. sp.

3. — Pereonite 5 anterior margin with spines; pereonites 5 and 6 with non-marginal dorsal spines ……....*Ilyarachna pacifica* n. sp.
   — Pereonites 5 and 6 without marginal and dorsal spines .....…… ……...……..*Ilyarachna taratara* n. sp.

4. — Pereonites 1–4 anterior margins with robust setae; pereonites 7 ventrally with spine/s ……..5
   —Pereonites 1–4 anterior margins without robust setae; pereonites 7 ventrally with no spines ……..…….....*Ilyarachna cheropin* n. sp.

5. — Pereonite 7 ventrally with single medial spine ……..……6
   — Pereonite 7 ventrally without single medial spine, instead with pair of small spines ……*Ilyarachna crystallum* n. sp.

6. — Pereonite 6 ventrally with ornamentation; mandibular palp article 2 without pectinate setae; pleopod 3 endopod with 3 plumose setae ……...7
   — These three characters not combined ……...9

7. — Cephalon with dorsal spines ……8
   — Cephalon without dorsal spines ……*Ilyarachna australis* n. sp.

8. — Cephalon with single pair of dorsal spines; pereopod 1 basis inferior margin with dense row of robust setae; mandiblar palp article 3 distally with 1 pectinate seta; male pleopod 2 stylet short, does not hook up into proximal half ...…….…....*Ilyarachna franki* n. sp.
   — Cephalon with more than single pair of dorsal spines; pereopod 1 basis inferior margin with evenly spread robust setae, not in a dense row;

mandiblar palp article 3 distally with many pectinate setae; male pleopod 2 stylet elongate, does hook up into proximal half …….....…..*Ilyarachna quorna* n. sp.

9. — Cephalon with no ornamentation; pereopod 1 basis inferior margin with robust setae; pleopod 3 endopod with 3 plumose setae; male pleopod 2 stylet long, hooking up into proximal half of protopod ….....…….....10
   — None of these characters combined ……...….……....11

10. — Pereonite 4 with anterolateral lobes; pereonite 5 lateral margin with no indentation; male antenna 1 elongate, of about 25 articles, article 3 over two-thirds length of article 2; pereopod 1 basis inferior margin with row of robust setae …….……*Ilyarachna mokari* n. sp
    — Pereonites 3 and 4 with anterolateral lobes; pereonite 5 lateral margins indent; male antenna 1 short, of about 14 articles, article 3 half the length of article 2; pereopod 1 basis inferior margin with robust setae at distal end only …….....…….*Ilyarachna flindersi* n. sp.

11. — Cephalon with 2 dorsal spines; antenna 2 article 1 anterolateral margin with 1 robust seta; pereopod 1 basis inferior margin with no robust setae; uropod biramous ……..*Ilyarachna aculeatus* n. sp.
    — None of these characters combined …….12
12. — Male stylet pleopod 2 short, not hooking up into proximal half of protopod; pleopod 3 endopod with 3 plumose setae; uropods biramous …….. *Ilyarachna moana* n. sp.
    — Male stylet pleopod 2 long, hooking up into proximal half of protopod; pleopod 3 endopod with more than 3 plumose setae; uropods uniramous ……*Ilyarachna kermadecensis* Wolff, 1962

***Ilyarachna aculeatus* n. sp. (Figs 4.17–4.19)**

Material examined.— All material New Zealand. Holotype. Male (3.2 mm), north-west slope, North Island, stn E892, 37°20'S, 173°35'E, Agassiz medium trawl, 24 March 1968, 1234–1224 m, MV *Taranui* (NIWA XXXX). Paratypes. 3 females, 2 males, 6 fragments (1 female 4.5 mm, 1 male 3.5 mm; dissected), type locality (NIWA XXXX).

Additional material.— 2 males, northeast slope, North Island, stn F910, 34°56'S, 175°23'E, Menzies trawl, 10 October 1968, 1459-1470 m, RV *Taranui* (NIWA XXXX). 1 female, Chatham Rise, South Island, stn S143, 44°28.0'S, 174°54.8'E, Agassiz medium trawl with fine mesh inside, 25 October 1979, 692 m, R.V *Tangaroa* (NIWA XXXX). 1 female, north-west slope, North Island, stn E901, 38°00'S, 173°19'E, Agassiz medium trawl, 25–26 March 1968, 1247–1250 m, MV *Taranui* (NIWA XXXX). 2 females, 1 male, Chatham Rise, South Island, stn S147, 44°30.1'S, 174°18.8'E, Agassiz medium trawl with fine mesh inside, 25 October 1979, 760 m, RV *Tangaroa* (NIWA XXXX).

Description. *Male*. Body about 3.3 times as long as greatest width of pereonite 2; widest at pereonite 4; cuticle not highly calcified, smooth. Cephalon cuticle smooth, with 2 spines; posterolateral margins broadly rounded. Pereonites 1–5 anterior margins with robust setae; pereonites 1–2 with pair of small tubercles; pereonite 5 anterolateral margin square, laterally with small indentation; anterolateral margins of pereonites all rounded except pereonite 4 which has small lobes; pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with medial spine. Pleon 1.4 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point.

Antenna 1 of 22 articles; article 1 article 1 length 1.4 times as long as wide, lateral margin with 2 SS and 1 SRS, surface with 1 PNS, each distal corner with 1 SRS and 1 PNS; article 2 2.6 times as long as wide, distal margin with 3 PNS and 1 SRS; article 3 with 2 SS (in distal half); article 4 with 2 PNS; article 6 with 2 SS; from article 8 onwards, each article with 1 aesthetasc and many with additional SS; terminal article with 1 SS.

Pleopod 1 12.6 times as long as proximal height, lateral margins indent 0.3 from proximal end, ventral surface with 20 SRS and 6 SS, distally with 12 SS (6+6). Pleopod 2 protopod 3.6 times as long as wide, lateral margin with row of plumose setae, surface with 12 SS, mesial margin with 4 SS, distally with lamellar extension; exopod hooked, 0.1 times as long as protopod with fine SS; stylet hooked up into protopod, long, 1.2 times as long as protopod, terminating to a point; sperm duct 0.7 times as long as stylet.

Female. Antenna 1 of 10 articles; article 1 1.4 times as long as wide, surface with 2 SS, 3 PNS and 1 SRS, lateral margin with 4 SS, each distal corner with 1 PNS and 1 SRS; article 2 elongate, 0.4 times as long article 1, 2.7 times as long as wide, distal end with 2 PNS and 1 SRS; article 3 with 8 SS; article 4 with 2 PNS; article 5 with 3 SS; article 6 with 2 SS, article 7 with 2 SS, terminal article with 1 SS and 1 aesthetasc. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 lateral margin with 1 RS; article 2 0.9 times as long as article 1, distolateral margin with 2 SS, surface with 6 SS; article 3 0.7 times as long as article 1, distal margin with 3 SS, scale with 1 RS and 2 SS, distomesial margin with 2 RS; article 4 1.1 times as long as article 1.

Mandible lacinia mobilis reduced and smooth, truncate; spine row with 8 spines; molar small, with 3 bi-serrate setae; mandibular palp extending beyond incisor, article 1 lateral margin with 5 SS, distomesial corner with 3 SS, article 2 with 2 small pectinate setae and cuticular scales, article 3 with 1 SS and 1 pectinate seta, cuticular scales present. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.0 times as wide as mesial lobe, distal margin with few fine SS, 6 RS, 1 dentate RS and 5 pectinate RS, mesial lobe distally with 1 SS, many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe surface and margins with scattered fine SS, distally with 4 long pectinate setae; middle lobe 1.1 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.5 times as wide as lateral lobe, margins and surface with fine SS, proximally, mesial margin also with approximately 13 bi-serrate setae, distally with 5 blunt SS, 7 toothed setae, and 1 long pectinate setae. Maxilliped coxa rectangular, 1.3 times as long as wide, 0.4 times as long as basis (including endite); basis elongate, 3.2 times as long as wide (including endite); endite with 6 coupling hooks, distally

with 4 toothed setae, 7 fan setae (distomesial one is longest), and many fine SS; palp article 1sub-rectangular, 0.4 times as long as basal endite, cuticular scales present, surface with 3 SS, distomesial margin with 1 SS; article 2 2.4 times as long as and 1.1 as wide as article 1, 1.3 times as wide as basal endite, lateral margin with cuticular scales and 6 SS, surface with 1 SS, mesial margin with 4 distally pappose setae; article 3 1.2 times as long as and 0.9 times as wide as article 1, lateral margin with 1 SS, mesial margin with 2 SS and 18 distally pappose setae; article 4 0.8 times as long as and 0.5 as wide as article 1, distomesial margin with 1 SS and 6 distally pappose setae; article 5 narrow, 0.7 times as long as and 0.2 times as wide as article 1, distally with 2 SS and 6 distally pappose setae; epipod 1.8 times as long as wide, and 1.3 times as long as basis, margins with many cuticular scales and 6 SS.

Pereopod 1 basis 7.6 times as long as wide, inferior margin with 30 SS, lateral surface with 17 SS, superior margin with 7 PNS and 19 SS; ischium 4.6 times as long as wide, inferior margin with 10 SS, lateral surface with 13 SS, superior margin with 2 SRS; merus 1.3 times as long as wide, inferior margin with 18 SS, lateral surface with 2 SS, distosuperior margin with 5 SS; carpus 5.8 times as long as wide, inferior margin with 10 SS, superior margin with 2 SS; propodus 9.2 times as long as wide, inferior margin with 3 SS (towards distal end), lateral surface with 5 SS, superior margin with 6 small SS; dactylus 4.3 times as long as proximal width, distosuperior margin with 3 SS.

Pereopod 7 basis 5.5 times as long as wide, inferior margin with 20 SS, lateral surface with 5 PNS; ischium 4.2 times as long as wide, inferior margin with 9 SS, lateral surface with 3 SS; merus 2.0 times as long as wide, inferior margin with 16 SS, distosuperior margin with 1 plumose setae; carpus 2.0 times as long as wide, lateral surface with 21 SS; propodus 10.1 times as long as wide, superior margin with 3 SS; dactylus 11.2 times as long as proximal width, distosuperior margin with 4 SS.

Operculum 3.3 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel with row of RS and a few SS, surface with scattered SS and 3 distal plumose setae, margins anterolaterally with 21 SS (11+10), laterally with numerous plumose setae. Pleopod 3 exopod

1.1 times as long as endopod, distally with 12 long plumose setae and 1 SS; endopod 2.3 times as long as wide, with 4 long plumose setae. Pleopod 4 exopod with 5 terminal long plumose setae; endopod oval, 1.8 times as long as wide. Pleopod 5 2.3 times as long as wide.

Uropod protopod 2.0 times as long as wide, distal end rounded, lateral margin with row of plumose setae and SS, distal margin with 5 plumose setae and 6 SS, mesial margin with 1 plumose seta, surface with 3 scattered plumose setae; exopod rudimentary, 0.05 times as long as protopod, 0.2 times as long as endopod, with 3 setae (sockets remaining); endopod 0.3 times as long as protopod, with 10 PNS.

Remarks. *Ilyarachna aculeatus* n. sp. is distinguished by a combination of: pereonite 5 anterior margin with robust setae and lateral margin with indentations; pereopod 1 basis with no robust setae; and pereopod 7 carpus with numerous simple setae. *I. aculeatus* is most similar to *Ilyarachna kermadecensis* Wolff, 1962 but is distinguished by: having only two spines on the cephalon which are also bigger than those found in *I. kermadecensis*; the lack of robust setae on the basis inferior margin and the setae on the carpus are concentrated in the proximal half in *I. aculeatus* rather than evenly spread as in *I. kermadecensis*; the operculum in *I. aculeatus* lacks the numerous plumose setae that are present on the distal surface in *I. kermadecensis*; and the uropod in *I. aculeatus* is biramous, not uniramous, and with fewer surface plumose setae than found in *I. kermadecensis*.

Distribution. *I. aculeatus* is known from the north-west slope of the North Island (Tasman Sea), New Zealand to the Chatham Rise, east of the South Island (Pacific Ocean) of New Zealand, at depths between 692–1470 metres.

Etymology. Aculeatus is Latin, meaning prickly or sharp-pointed, referring to the acute robust setae that adorn the anterior margins of pereonites 1–4.

***Ilyarachna australis* n. sp. (Figs 4.20–4.21)**

Material examined.— All material New Zealand. Holotype. Female (4.0 mm), Bounty Trough, South Island, stn S154, 45°24.2'S, 173°59.8'E, epibenthic sled, 27 September 1979, 1373 m, RV *Tangaroa* (NIWA XXXX). Paratype. 1 female (3.5 mm), Bounty Trough, South Island, stn S152, 45°52.3'S, 174°04.9'E, epibenthic sled, 26 September 1979, 1676 m, RV *Tangaroa* (NIWA XXXX).
Additional material.— 2 females, Chatham Rise, South Island, stn S132, 43°37.9'S, 175°58.0'E, Menzies trawl, 21 September 1979, 322 m RV *Tangaroa* (NIWA XXXX). 2 females, 1 fragment, Chatham Rise, South Island, stn S148, 44°41.0'S, 174°20.9'E, Agassiz medium trawl with fine mesh inside, 25 September 1979, 859 m, RV *Tangaroa* (NIWA XXXX).

Description. Body about 2.6 times as long as greatest width of pereonite 2; widest at pereonite 3; cuticle not highly calcified, smooth. Cephalon cuticle smooth, spines absent; posterolateral margins broadly rounded; Pereonites 1–2 anterior margins with few robust setae, setae on pereonites 3 and 4 not intact. Pereonite 5 anterior margin smooth; anterolateral margins of pereonites all rounded except pereonites 3 and 4 which have small anterolateral lobes; pereonites 6 and 7 ventrally each with medial spine. Pleon 1.4 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point.

Antenna 1damaged; article 1 approximately 1.3 times as long as wide, surface with 1 PNS and 1 SS (both in distal half), lateral margin with 5 SS, distal margin with 2 SRS and 1 PNS; article 2 0.7 times as long article 1, 3.7 times as long as wide, inferior margin with 1 SS, distally with 4 RS and 3 PNS; article 3 with 1 SS; article 4 with 2 PNS; article 5 with 2 SS; article 6 with 2 SS; article 7 with 2 SS. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 lateral margin with 1 RS; article 2 approximately 1.4 times as long as article 1, mesial margin with 1 SS; article 3 approximately 2.2 times as long as article 1, scale with 3 SS and 1 RS, mesial margin with 3 SS and 2 RS; article 4 small, 1.6 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis reduced, with distal point; spine row with 9 spines (on left mandible, 8 on right); molar small, terminated with 3 uni-serrate setae (on left molar, 2 on right); mandibular palp extending beyond incisor, article 1 with 5 SS (on left mandibular palp, 4 on right), article 3 with 1 long SS and 1 long pectinate seta. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.0 times as wide as mesial lobe, distal margin with few fine SS, 5 RS, 3 dentate RS and 4 bi-serrate RS, mesial lobe distally with many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 0.9 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.3 times as wide as lateral lobe, mesial and distal margins and surface with fine SS, proximally, mesial margin also with 10 long SS, distally with 8 blunt SS, 3 toothed setae and 1 long pectinate setae. Maxilliped coxa narrow, 1.5 times as long as wide, 0.4 times as long as basis (including endite); basis elongate, 3.1 times as long as wide (including endite), with 6 scattered SS; endite with 5 coupling hooks, distally with 4 blunt SS, 8 fan setae and many fine SS; palp article 1 short, trapezoid, 0.5 times as long as basal endite, cuticular scales present, distolateral margin with 1 SS, surface with 3 SS, distomesial margin with 1 SS; article 2 2.0 times as long as and 1.2 as wide as article 1, 1.4 times as wide as basal endite, lateral margin with 3 SS and 1 RS, surface with 1 distally pappose seta and 1 SS, mesial margin with 3 distally pappose setae and 1 SS; article 3 as long as and as wide as article 1, lateral margin with 1 RS, surface with 3 distally pappose setae, mesial margin with 1 SS and 17 distally pappose setae; articles 4 and 5 rectangular; article 4 0.6 times as long as and 0.4 as wide as article 1, lateral margin with 1 SS, distal margin with 3 SS and 7 distally pappose setae; article 5 small, narrow, 0.7 times as long as, and 0.2 times as wide as article 1, with 9 terminal SS; epipod 1.6 times as long as wide, 1.2 times as long as basis, margins with cuticular scales and few scattered SS.

Operculum approximately 2.1 times as long as proximal width, medial keel provided with row of RS, proximally with 2 SS, distal surface with 8 plumose setae (4+4, sockets visible only), medial excision and veined lamellar extension, surface with scattered SS, margins anterolaterally with 13 SS (1 at

least +12), laterally with numerous plumose setae. Pleopod 3 exopod, 1.2 times length of endopod, distally with 10 long plumose setae and 1 SS; endopod 2.2 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 4 terminal long plumose setae; endopod oval, about 2.3 times as long as wide. Pleopod 5 1.9 times as long as wide.

Uropods missing.

Males are not known for this species.

Remarks. *Ilyarachna australis* n. sp. is distinguished by the combination of: pereonites 6 and 7 both with ventral spines; the cephalon has no ornamentation; the distolateral margin of antenna 1 is rounded; and the ventral surface of the operculum has many simple setae. *I. australis* closely resembles *Ilyarachna mokari* n. sp. as both species have relatively fewer robust setae on the anterior margins of pereonites 1–4 than other species with robust setae on these margins, and have no robust setae on the cephalon. *I. australis* differs from *I. mokari* in having a spine on the ventral side of pereonite 6, while in *I. mokari*, this spine is absent, and the distal margin of antenna 1 article 1 is rounded in *I. australis*, while in *I. mokari* it has developed into two points, each with a robust seta. The maxilliped in *I. australis* is more setose, both in terms of the endite having more fan setae and the palp comprising of many more distally pappose setae than in *I. mokari*. Also, the operculum in *I. australis* has many more simple setae on its ventral surface then in *I. mokari*.

Distribution. From the Chatham Rise to the Bounty Trough, east of the South Island, New Zealand between 322–1676 metres.

Etymology. Australis is Latin meaning south, referring to this species coming from the Southern Hemisphere.

Ilyarachna cheropin n. sp. (Figs 4.22–4.25)

Material examined.— All material from south-eastern Australia. Holotype. Female (3.0 mm), 76 km S of Point Hicks, Victoria, stn SLOPE 69, from 38°26.81'–29.33'S, 149°19.98'–20.78'E, 26 October 1988, WHOI epibenthic sled, 1840–1750 m, RV *Franklin*, sandy mud, fine shell (NMV JXXXX).

Paratypes. 4 males, 2 females and 11 fragments (1 male, 3.0 mm, dissected; 1 male, 2.5 mm, dissected), type locality (NMV JXXXX).

Additional material.— 2 males, 3 females, 54 km ESE of Nowra, NSW, stn SLOPE 53, from 34°52.72'–54.3'S, 151°15.04'–19.5'E 22 October 1988, WHOI epibenthic sled, 996–990 m, RV *Franklin*, mud, fine sand, fine shell (NMV J18869). 2 males, 2 females and 2 fragments, south of Point Hicks, Vic., stn SLOPE 27, 38°25.00'S, 149°0.00'E, 22 July 1986, WHOI epibenthic sled, 1500 m, RV *Franklin*, compacted clay (NMV J18867). 1 male, off Nowra, NSW, stn SLOPE 7, 34°52.29'S, 151°15.02'E, 15 July 1986, WHOI epibenthic sled, 1096 m, RV *Franklin*, shell (NMV J18865).

Description. Female. Body 2.8 times as long as greatest width of pereonite 2; widest at pereonite 3; cuticle smooth, not highly calcified. Cephalon smooth, spines absent; posterolateral margins broadly rounded;. Pereonites 1–5 anterior margins smooth, no ornamentation; anterolateral margins rounded except for pereonites 3 and 4 with small lobes; pereonites 6 and 7 ventrally with no ornamentation. Pleon 1.4 times as long as proximal width, posterior tip rounded.

Antenna 1 of 10 articles; article 1 1.2 times as long as wide, surface with 3 SS, lateral margin with 6 SS, distal margin with 4 SRS and 1 PNS; article 2 cylindrical, 0.5 times as long article 1, and 2.9 times as long as wide, mesial margin with 1 PNS at mid-point ,distal rim with 3 SRS and 3 PNS; article 4 with 2 PNS; article 5 with 2 SS; article 6 with 3 SS; article 7 with 1 SS; from article 8, each article has an aesthetasc and some have an additional simple seta; terminal article with 2 SS and 1 distal aesthetasc.

Operculum 4.8 times as long as proximal width, medial keel provided with row of RS and SS, distal surface with 1 plumose seta, few scattered setae, medial excision and veined lamellar extension, margins anterolaterally with 19 SS (9+10), laterally with numerous plumose setae.

Male. Antenna 1 of 28 articles; article 1 1.1 times as long as width, lateral margin with 2 SS and 2 SRS, distal margin with 4 SRS and 2 PNS; article 2 2.0 times as long as wide and 0.8 times the length of article 1, mesial margin with 1

PNS at midpoint, distally with 4 SRS and 3 PNS; article 3 with 1 SS; article 4 with 2 PNS; article 5 with 2 SS; from article 6 onwards, each article has 1 aesthetasc and many with additional setae; terminal article with 2 SS and 1 aesthetasc. Antenna 2 damaged; articles 1–3 more or less triangular; antenna 1 distolateral margin with 1 SRS; article 2 1.1 times as long as article 1, with 2 SRS on distolateral margin; article 3 2.0 times as long as article 1, scale with 2 SRS; article 4 slightly elongate, 2.1 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis reduced, distally with 2 points; spine row with 6 spines (on left mandible, 5 spines on right); molar small, distally with 3 uni-serrate setae; mandibular palp extending beyond incisor, article 1 with 13 SS (on left mandibular palp, 7 on right mandibular palp), article 2 with 2 small pectinate setae and cuticular scales, article 3 with 5 SS (on left mandibular palp, 7 SS on right mandibular palp). Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.8 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 1 dentate RS 7 pectinate RS and 1 pectinate dentate RS, mesial lobe terminated with many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins and surface with scattered fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.2 times as wide as lateral lobe, margins and surface with fine SS, proximally, mesial margin also with 5 elongate bi-serrate and 3 elongate SS, distally with 9 blunt SS, 6 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, 0.9 times as long as wide and 0.3 times as long as basis (including endite); basis elongate, 3.1 times as long as wide (including endite), with 4 SS; endite with 3 coupling hooks, 3 toothed setae, 5 fan setae (distomesial one is longest) and few fine SS; palp article 1 wide, short, 0.2 times as long as basal endite, lateral margin with cuticular scales, distolateral corner with 1 SS, surface with 3 SS, distomesial margin with 1 SS; article 2 2.8 times as long as and 1.4 as wide as article 1, 1.0 times as wide as basal endite, lateral margin with 7 SS, surface with 3 SS, mesial margin with 5 distally pappose setae; article 3 1.3 times as long as, and 1.0 times as wide as article 1, lateral margin with 1 SS, mesial margin with 3 SS and 13 distally pappose setae; article 4 1.0 times as long as and 0.5 as wide as

article 1, lateral margin with 2 SS and 6 distally pappose setae; article 5 narrow, 1.0 times as long as and 0.2 times as wide as article 1, lateral margin with 2 SS, terminally with 6 distally pappose setae; epipod 1.5 times as long as wide, 1.1 times as long as basis, margins with many cuticular scales and 2 SS.

Pereopod 1 basis 5.9 times as long as wide, inferior margin with 14 evenly spread SRS, lateral surface with 4 SRS, superior margin with 22 SS and 1 PNS; ischium 4.4 times as long as wide, inferior margin with 3 sub-marginal SS, lateral surface with 1 SS, superior margin with 3 SRS and 5 SS, distal margin with 4 SS; merus 1.1 times as long as wide, inferior margin with 9 SS, distosuperior margin with 3 SS; carpus 6.1 times as long as wide, inferior margin with 5 SS (4 in proximal clump), superior margin with 3 SS; propodus 7.9 times as long as wide, inferior margin with 17 SS, superior margin with 51 SS; dactylus 3.4 times as long as proximal width, superior margin with 4 distal SS.

Pereopod 5 basis 2.7 times as long as wide, inferior margin with 20 SS, superior margin with 12 SS (all in distal half); ischium 2.4 times as long as wide, inferior margin with 11 SS, lateral surface with 12 SS, superior margin with 3 SS (at distal end); merus 0.8 times as long as wide, inferior margin with 8 SS, distosuperior margin with SS and 1 short plumose setae; carpus 1.1 times as long as wide, lateral surface with 5 SRS and 5 small scattered SS, distosuperior margin with 3 SRS and 1 SS; propodus 3.2 times as long as wide, inferior margin with 1 SS, lateral surface with 8 small SS, superior margin with 1 PNS and 2 SS; dactylus 5.6 times as long as proximal width, superior margin with 6 SS.

Pereopod 6 basis damaged, inferior margin with at least 29 SS, lateral surface with at least 1 SS and 11 SRS (on opposing surface), superior margin with at least 11 SS; ischium 2.8 times as long as wide, inferior margin with 47 SS, superior margin with 2 SS (both in distal half); merus 1.1 times as long as wide, inferior margin with 11 SS, distosuperior margin with 1 SS and 1 small plumose seta; carpus 1.5 times as long as wide, lateral surface with 7 SS, superior margin with 2 SRS; propodus 3.8 times as long as wide, distoinferior margin with 2 SS, lateral surface with 7 SS, distosuperior margin with 3 SS and 1 PNS; dactylus 6.9 times as long as proximal width, superior margin with 7 SS.

Pleopod 1 14.5 times as long as proximal height, lateral margins indent 0.4 from proximal end, with 14 SRS and 12 SS. Pleopod 2 protopod 3.1 times as long as wide, lateral margin with 9 SS (7 proximal and 2 distal) and row of plumose setae, distally with lamellar extension, mesial margin with 5 plumose setae; exopod hooked, 0.2 times as long as protopod, with fine SS; stylet elongate, terminating to a point (tip broken off). Pleopod 3 exopod 1.3 times length of endopod, distally with 6 long plumose setae and 1 submarginal SS; endopod 1.6 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 3 terminal long plumose setae; endopod oval, 2 times as long as wide. Pleopod 5 2.0 times as long as wide.

Uropod protopod approximately 2.0 times as long as wide, distal end rounded, lateral margin with 4 plumose setae and 3 SS, distal margin with 2 plumose setae, mesial margin with 2 plumose setae; exopod rudimentary, 0.05 times as long as protopod, 0.1 times as long as endopod, with 4 SS; endopod 0.4 times as long as protopod, with 12 SS.

Remarks. *Ilyarachna cheropin* n. sp. is distinguished by a combination of: cephalon without ornamentation; smooth pereonites with no robust setae; pereonites 6 and 7 with no ventral ornamentation; pereopod 1 basis and propodus with many setae; and mandible palp article 3 terminally with many setae.

I. cheropin resembles *I. longicornis* as both species have a smooth cephalon, a smooth body and pereonites 6 and 7 with no ventral ornamentation. *I. cheropin*, can be distinguished from *I. longicornis* by: pereonite 6 anterior margin is more domed in *I. cheropin* than in *I. longicornis*; antenna 1 article 1 has more lateral setae in *I. cheropin* than in *I. longicornis*; mandibular palp article 3 distally has many more setae than in *I. longicornis*; and the presence of more setae in *I. cheropin* on the basis of pereopods 1 and 5 and on the propodus of pereopod 1.

Distribution. Australia, between Nowra, NSW and south of Point Hicks, Victoria between 990–1840 metres.

Etmology. Cheropin is an Aboriginal word for swim; noun in apposition.

***Ilyarachna crystallum* n. sp. (Figs 4.26–4.27)**

Material examined.— Holotype. Female (3.2 mm), off Freycinet Peninsula, Tas., Australia, stn SLOPE 46, 42°0.20'S, 148°37.70'E, 27 July 1986, WHOI epibenthic sled, 720 m, RV. *Franklin*, coarse shelly sand (NMV JXXXX). Paratypes. 2 females (4.0 mm, dissected; 3.0 mm), type locality (NMV JXXXX).

Description. Female. Body about 2.5 times as long as greatest width of pereonite 2; widest at pereonite 2; cuticle not highly calcified, smooth. Cephalon with no spines; posterolateral margins broadly rounded. Pereonites 1–4 anterior margins with robust setae (setae on pereonite 4 not intact); anterolateral margins of pereonites 1, 2, 6 and 7 rounded, pereonites 3 and 4 with small lobes, pereonite 5 anterolateral margin square; pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with two small spines. Pleon 1.4 times as long as proximal width, posterior tip rounded.

Antenna 1 of 10 articles; article 1 1.1 times as long as wide, surface with 2 SS and 2 PNS, lateral margin with 6 SS, distomesial margin with 1 SRS and 1 SS, distolateral margin with 2 SRS; article 2 cylindrical, 0.5 times as long article 1, 2.4 times as long as wide, distally with 3 SRS and 3 PNS; article 3 distally with 4 SS; article 4 with 1 PNS; from article 5, each have distal SS, from article 9 onwards each with aesthetasc; terminal article with 3 SS, 1 PNS and 1 aesthetasc. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 lateral margin with 1 RS; article 2 2.0 times as long as article 1, with distolateral RS similar to article 1; article 3 2.0 times as long as article 1, scale with 1 SRS, distomesial margin with 2 SRS; article 4 small, 1.6 times as long as article 1, with no ornamentation.

Mandible cuticular scales; lacinia mobilis reduced, tooth-like, with 1 main one and 2 small cusps; spine row with 3 spines (on left mandible, 4 on right); molar large, distally with 3 uni-serrate setae; mandibular palp extending beyond incisor, palp article 1 with 2 SS (on left palp, right palp article 1 with 4 SS), articles 2 and 3 covered with crystals, illustrations are approximate, article 3 with 1 SS and 1 long pectinate seta. Maxilla 1 lateral and mesial margins with

fine SS; lateral lobe 1.8 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 3 dentate RS and 6 pectinate RS, mesial lobe terminated with 6 SS, many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 0.8 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.2 times as wide as lateral lobe, margins and surface with fine SS, proximally, mesial margin also with 10 long bi-serrate setae, distally with 5 blunt SS, 5 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, 1.1 times as long as wide, 0.4 times as long as basis (including endite); basis elongate, 2.9 times as long as wide (including endite), with 5 scattered SS; endite with 4 coupling hooks, 3 blunt bi-serrate setae, 5 fan setae (distomesial one is longest) and many fine SS; palp article 1 sub-rectangular, 0.4 times as long as basal endite, with cuticular scales, surface with 4 scattered SS; article 2 3.1 times as long as and 1.3 as wide as article 1, 1.3 times as wide as basal endite, lateral margin with 1 RS and 6 SS, mesial margin with 5 distally pappose setae; article 3 1.4 times as long as, and 1.0 times as wide as article 1, lateral margin with 1 SS, distomesial margin with 1 SS and 13 distally pappose setae; article 4 1.2 times as long as and 0.5 as wide as article 1, lateral margin with 1 SS, distal margin with 3 SS and 6 distally pappose setae; article 5 narrow, 1.0 times as long as and 0.2 times as wide as article 1, with 2 SS, 1 pectinate seta and 6 distally pappose setae; epipod 1.9 times as long as wide, 1.2 times as long as basis, margins with cuticular scales and 7 scattered SS.

Operculum 2.0 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with few RS, proximally with 3 small SS, distal surface probably with plumose setae (some sockets are visible, but this are is badly effected by crystals), surface with scattered SS, margins anterolaterally with 18 SS (8+10), laterally with numerous plumose setae. Pleopod 3 exopod 1.0 times length of endopod, distally with 12 long plumose setae and 1 SS; endopod 2.2 times as long as wide, with 5 long plumose setae. Pleopod 4 with 5 terminal long plumose setae; endopod oval, 1.7 times as long as wide. Pleopod 5 2.1 times as long as wide.

Uropod protopod 2.0 times as long as wide, distal end rounded, margins with few cuticular scales, lateral margin with 19 setae (10 RS and 9 sockets clearly visible, type of setae unknown) , distal margin with 4 robust plumose setae and 3 plumose setae, mesial margin with 2 plumose setae; endopod 0.3 times as long as protopod, with 2 PNS and 10 SS.

Males are not known from this species.

Remarks. *Ilyarachna crystallum* n. sp. is distinguished by the combination of: cephalon with few scattered robust setae; pereonites 1–4 anterior margins with few robust setae; pereonite 7 ventrally with 2 spines and a uniramous uropod.

I. crystallum resembles *Ilyarachna antarctica*, but can be distinguished from this species by: pereonite 4 anterolateral margins with acute lobes, which, in *I. antarctica* are much smaller processes; mandibular palp article 2 is sub-equal with article 1 in *I. antarctica*, while it is longer in *I. crystallum*; and pereonite 7 ventrally has 2 spines as opposed to *I. antarctica* which only has 1 medial spine.

Distribution. Known only from type locality, off Freycinet Peninsula, Tasmania, Australia, at a depth of 720 metres.

Etymology. Crystallum is Latin meaning crystal, in this case referring to the many crystals which had formed on the setae of the specimens studied.

Ilyarachna flindersi n. sp. (Figs 4.28–4.30)

Material examined.— Holotype. Female (2.5 mm), Flinders Canyon, eastern Bass Strait, Australia, 79-K-1 stn 34, 39°38.7’S, 148°49.4’E, 27 March 1979, dredge, 770 m, HMAS *Kimbla*, shell/sand (ex NMV J18882). Paratypes. 7 females (1 female, 4.0 mm, dissected; 1 female, 3.5 mm, partially dissected), type locality (ex NMV J18882). Male (2.0 mm) 57 km E of Nowra, NSW, Australia, stn SLOPE 62, 34°53.57’S, 151°14.09’E, 23 October 1988, 0.1 m^2 box corer, 1011 m, RV *Franklin*, green–grey sandy mud (NMV J18881).

Description. *Female.* Body about 2.5 times as long as greatest width of pereonite 2; widest at pereonite 2; cuticle not highly calcified, smooth. Cephalon

cuticle smooth, with no spines; posterolateral margins broadly rounded. Pereonites 1–4 anterior margins with robust setae; pereonite 5 anterior margin smooth, laterally with small indentation; anterolateral margins of pereonites all rounded except pereonite 4 which has small anterolateral lobes. Pleon 1.2 times as long as proximal width, posterior tip rounded.

Antenna 1 of 9 articles; article 1 slightly triangular, 1.1 times as long as wide, surface with 1 SS, distosuperior margin with 2 RS (one is socket only); article 2 0.5 times as long article 1, 2.6 times as long as wide, with 4 setae (sockets only, but most likely SRS); article 3 with 1 distal SS; article 4 with 2 PNS; article 5 with 2 SS; article 6 with 2 SS; from article 7, each article has 1 aesthetasc and many articles have additional setae; terminal article with 2 SS and 1 distal aesthetasc.

Antenna 2 not complete; articles 1–3 more or less triangular; article 1 lateral margin with 2 RS; article 2 1.1 times as long as article 1, with no setae; article 3 1.2 times as long as article 1, scale with, 1 RS; article 4 small, 0.8 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis truncate; spine row with 8 spines; molar small, with 3 bi-serrate setae; mandibular palp extending beyond incisor, article 1 with 2 SS (on left palp, 4 SS on right palp), article 3 distally with 1 long pectinate seta and 1 SS. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.7 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 3 dentate RS and 6 pectinate RS, mesial lobe distally with 10 SS, numerous fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.2 times as wide as lateral lobe, margins and surface with fine SS, proximally, mesial margin also with 3 long bi-serrate setae and 2 long SS, distally with 9 blunt SS, 9 toothed setae and 1 long pectinate setae. Maxilliped coxa rectangular, 1.5 times as long as wide, 0.4 times as long as basis (including endite); basis elongate, 3.2 times as long as wide (including endite); endite with 6 coupling hooks, distally with 5 bi-serrate setae, 6 fan setae and many fine SS; palp article 1 sub-rectangular, 0.4 times as long as basal endite, with cuticular scales, distomesial margin with 1 SS; article 2 2.6 times as long as

and 1.4 as wide as article 1, 1.8 times as wide as basal endite, lateral margin with cuticular scales and 4 SS, surface with 3 SS, mesial margin with 5 distally pappose setae; article 3 1.4 times as long as and 0.9 times as wide as article 1, surface with 3 SS and 1 distally pappose, mesial margin with 1 SS and 14 distally pappose setae; article 4 0.8 times as long and 0.5 as wide as article 1, distolateral margin with 1 SS, distomesial margin with 1 SS and 8 distally pappose setae; article 5 narrow, 0.7 times as long as and 0.2 times as wide as article 1, distally with 1 SS, 1 pectinate setae and 4 distally pappose setae; epipod 1.6 times as long as wide, and 1.1 times as long as basis, margins with cuticular scales and 3 SS.

Pereopod 1 basis 4.8 times as long as wide, inferior margin with 4 SRS, 1 PNS and 6 SS, lateral surface with 3 SS and 1 PNS; ischium 2.5 times as long as wide, inferior margin with 3 SS, lateral surface with 3 long SS, superior margin with 2 long RS and 1 long SS; merus 1.1 times as long as wide, inferior margin with 8 SS, distosuperior margin with 2 SS and 1 RS; carpus 4.0 times as long as wide, inferior margin with 12 SS, superior margin with 4 SS; propodus 6.1 times as long as wide, inferior margin with 12 SS, lateral surface with 3 SS, superior margin with 3 SS; dactylus 4.4 times as long as proximal width, superior margin with 3 small SS (in distal clump).

Pereopod 6 basis 3.4 times as long as wide, inferior margin with 8 SS, lateral surface with 7 SS, superior margin with 2 SS; ischium, 2.3 times as long as wide, inferior margin with 2 SS, lateral surface with 3 SS, superior margin with 2 sub-marginal SS; merus 1.1 times as long as wide, inferior margin with 3 SS, lateral surface with 2 SS, distosuperior margin with 1 SS; carpus 1.2 times as long as wide, lateral surface with 4 SS, superior margin with 1 SRS; propodus 3.3 times as long as wide, distoinferior margin with 2 SS, distosuperior margin with 1 SS; dactylus 6.7 times as long as proximal width with 4 SS (in distal clump).

Operculum 2.0 times as long as proximal width, distally medial excision, medial keel provided with row of RS, surface with scattered setae, distally surface with 5 plumose setae (on left, right side too damaged), margins anterolaterally with 7 SS (3+4), laterally with numerous plumose setae. Pleopod

3 exopod, 1.3 times length of endopod, distally with 6 long plumose setae and 1 distal SS; endopod 2.0 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 3 terminal long plumose setae; endopod oval, 1.7 times as long as wide. Pleopod 5 1.9 times as long as wide.

Uropod protopod 1.8 times as long as wide, oval, distal end rounded, lateral margin with 6 plumose setae and 3 RS, distal margin with 2 plumose setae and 6 RS, mesial margin with 2 plumose setae, surface with 2 plumose setae; exopod rudimentary, with 3 SS; endopod 0.3 times as long as protopod, distally with 6 PNS and 4 SS.

Male. Pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with medial spine on sternum.

Antenna 1 of 14 articles; article 1 1.2 times as long as, mesial margin with 1 SS, distomesial margin with 1 SRS and 1 PNS, surface with 1 SS, lateral margin with 1 SRS and 2 PNS, , distolateral margin with 1 PNS; article 2 2.5 times as long as wide, mesial margin with 1 PNS, distal margin with 3 PNS and 4 SRS; article 3 with 1 SS; article 4 mesial margin with 2 PNS; article 6 with 1 SS; from article 8 onwards, each article has 1 aesthetasc and many articles with additional SS; terminal article with 2 SS, 1 PNS and 1 distal aesthetasc.

Pleopod 1 3.4 times as long as proximal width, lateral margins indent 0.4 from proximal end, either side of central margin with 15 SS (4 SRS, 3 SS + 4 SS, 4 SRS), distally with 11 SS (6 + 5). Pleopod 2 protopod 3.2 times as long as wide, lateral margin with 3 SS (in proximal half), and row of plumose setae, surface with 2 SS, distally with lamellar extension, mesial margin with 1 SS (in same position left pleopod 2 with 4 plumose setae); exopod hooked, 0.1 times as long as protopod, with fine SS; stylet long, 1.5 times as long as protopod, hooked up into proximal part of protopod, terminating to a point; sperm duct 0.7 times as long as stylet.

Remarks. *Ilyarachna flindersi* n. sp. is distinguished by the combination of: the smooth cephalon; pereonites 1–4 anterior margins with robust setae; the absence of anterolateral lobes on pereonite 3; pereonite 5 with lateral indentations; only pereonite 7 with ventral ornamentation; pereopod 1 basis inferior margin with penicillate setae; and male pleopod 2 with an elongate

stylet, which hooks up into the proximal half of the protopod. *I. flindersi* resembles *Ilyarachna mokari*, but male antenna 1 is much longer in *I. mokari* than in *I. flindersi*, and article 3 is two-thirds the length of article 2 in *I. mokari*, while in *I. flindersi* article 3 is only half the length of article 2. Pereonite 5 of *I. flindersi* has a lateral indentation, which is not present in *I. mokari*, antenna 2 article 1 and the scale on article 3 have more setae. The basis of pereopod 1 in *I. flindersi* is more slender than that of *I. mokari* and has a different setal pattern. In *I. flindersi* the basis superior margin is without setae (setae present in *I. mokari*) and the inferior margin only has robust setae on the distal half (robust setae are evenly spread in *I. mokari*).

Distribution. South-eastern Australia, from Nowra NSW to Flinders Canyon, Bass Strait, between 770–1011 metres.

Etymology. *I. flindersi* is named after the type locality, the Flinders Canyon.

***Ilyarachna franki* n. sp. (Figs 4.31–4.33)**

Material examined.— Holotype. Female (9.5 mm), Hikurangi Trough, North Island, New Zealand, stn P971, 41°11.9'S, 177°19.6'E, epibenthic sled, 18 June 1980, 2200–2328 m, RV *Tangaroa* (NIWA XXXX). Paratypes. 1 female (8.5 mm), 1 male (6.0 mm), Bounty Trough, South Island, New Zealand, stn S151, 45°45.8'S, 174°30.5'E, epibenthic sled, 26 September 1979, 1586 m, RV *Tangaroa* (NIWA XXXX).

Additional material.— 1 Female, Bounty Trough, South Island, New Zealand, stn S152, 45°52.3'S, 174°04.9'E, epibenthic sled, 26 September 1979, 1676 m, RV *Tangaroa* (NIWA XXXX).

Description. Female. Body about 2.8 times as long as greatest width of pereonite 2; widest at pereonite 2; cuticle calcified, smooth. Cephalon with 2 spines; posterolateral margins broadly rounded; Pereonites 1–4 anterior margins with robust setae; pereonite 5 anterior margin smooth; anterolateral margins of pereonites all rounded except pereonites 3 and 4 which have small lobes;

pereonites 6 and 7 ventrally each with medial spine. Pleon 1.3 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point.

Antenna 1 damaged; article 1 1.2 times as long as wide, mesial margin with 3 SS, surface with 1 RS, 2 SS and 5 long PNS, lateral margin with 2 SS and 1 long PNS; article 2 cylindrical, 0.6 times as long article 1, 3.0 times as long as wide, with 3 SS and 1 PNS (all distal end); article 4 with 2 PNS; article 5 distomesial margin with 1 SS; article 6 with 2 SS; from article 8, each article has and aesthetasc. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 lateral margin with 1 RS; article 2 1.0 times as long as article 1, with no setae; article 3 1.4 times as long as article 1; article 4 small, 1.3 times as long as article 1, with no ornamentation.

Mandible with few cuticular scales; lacinia mobilis reduced and smooth, truncate; spine row with 11 spines; molar small, with 3 bi-serrate setae; mandibular palp extending beyond incisor, palp article 3 with 1 pectinate seta and 1 SS. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.0 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 3 dentate RS, and 6 pectinate RS, mesial lobe distally with 10 SS, many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.9 times as wide as lateral lobe, margins with fine SS, proximally, mesial margin also with 17 long bi-serrate setae, distally with 11 blunt SS, many fine SS, 6 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, 1.1 times as long as wide, 0.4 times as long as basis (including endite); basis elongate, 2.7 times as long as wide (including endite), distolateral margin with 1 SS; endite with 7 coupling hooks, 6 bi-serrate setae, 8 fan setae and many fine SS; palp article 1 rectangular, 0.3 times as long as basal endite, cuticular scales present, distolateral margin with 2 SS, distomesial margin with 1 SS; article 2 3.6 times as long as and 1.4 as wide as article 1, 1.1 times as wide as basal endite, lateral margin with 9 SS and 1 distal RS, mesial margin with 7 distally pappose setae; article 3 1.8 times as long as and 0.9 times as wide as article 1, lateral margin with 1 SS and 26 distally pappose setae; article 4 1.2 times as long and 0.5 as wide as article 1, distal margin with 2 SS and 4 distally

pappose setae; article 5 narrow, 1.0 times as long as, and 0.2 times as wide as article 1, with 4 distally pappose setae and 1 SS; epipod 1.5 times as long as wide, 1.1 times as long as basis, margins with cuticular scales and few scattered SS.

Pereopod 1 basis 3.7 times as long as wide, inferior margin with 29 SRS, lateral surface with 11 SRS and 5 small SS (all in distal half), superior margin with 5 PNS and 12 small SS; ischium 3.0 times as long as wide, inferior margin with 13 SS, lateral surface with 9 SS (in distal half), superior margin with 2 RS and 7 SS; merus 1.2 times as long as wide, inferior margin with 19 RS, lateral surface with 4 SS, distosuperior margin with 1 SS and 1 SRS; carpus 3.6 times as long as wide, inferior margin with 16 SRS, 13 RS and 13 SS, distosuperior margin with 2 SS; propodus 6.7 times as long as wide, inferior margin with 31 SS (15 are sub-marginal), superior margin with 2 SS; dactylus 2.5 times as long as proximal width, superior margin with 4 SS (in distal clump).

Operculum 2.5 times as long as proximal width, medial keel provided with row of RS (although only sockets remain), distal surface with 2 plumose setae (and 11 sockets visible), numerous scattered SS, medial excision and veined lamellar extension, lateral margins with numerous plumose setae. Pleopod 3 exopod 1.2 times length of endopod, distally with 12 long plumose setae and 1 SS; endopod 2.3 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 6 terminal long plumose setae; endopod oval, 1.6 times as long as wide. Pleopod 5 2.0 times as long as wide.

Uropod protopod 2.6 times as long as wide, rectangular, lateral margin with 17 SS and 20 plumose setae, distal margin with 4 plumose setae, mesial margin with 2 plumose setae, surface with 5 scattered plumose setae; exopod rudimentary, with 2 setae (both broken, but most likely SS); endopod missing.

Male. Antenna 1 of 40 articles; article 1 1.7 times as long as wide, surface with 3 SS and 4 PNS, distal margin with 3 RS; article 2 3.6 times as long as wide, lateral margin with 1 PNS, distomesial margin with 1 SRS; article 3 surface with 2 SS; from article 7 onwards, each article has an aesthetasc and many articles with additional setae; terminal article with 1 PNS and an aesthetasc.

Pleopod 1 4.6 times as long as proximal width, lateral margins indent 0.5 from proximal end, with 13 SS (7+6, all in proximal half), either side of central margin with 35 setae (15+13 RS and 3+4 SS), distally with 21 SS (13+8). Male pleopod 2 protopod 4.1 times as long as wide, lateral margin with 9 SS (in proximal half), and row of plumose setae, surface with 9 SS proximally, distally with 2 SS, 8 plumose setae and lamellar extension, mesial margin with 7 plumose setae; exopod hooked, 0.1 times as long as protopod, with fine SS; stylet 0.8 times as long as protopod, not hooked into protopod, terminating to a point; sperm duct 0.6 times as long as stylet.

Remarks. *Ilyarachna franki* n. sp. can be distinguished by: the large size; a pair of large cephalic spines; robust setae pereonites 1–4 anterior margins; and pereonites 6 and 7 each with a medial spine. *I. franki* is most similar to *Ilyarachna aculeatus* and *Ilyarachna quorna* as all three species have robust setae on the first four pereonites and spines on the cephalon. *I. franki* however, has a shorter stylet on male pleopod 2 which does not hook up into the proximal part of the protopod as it does in the other two species. In addition, *I. franki* can be distinguished from *I. aculeatus* as *I. franki* has no robust setae on the anterior margin of pereonite 5, the pair of spines on the cephalon are larger in comparison to *I. aculeatus*, and pereopod 1 is more robust and has many robust sensillate setae on the basis and carpus which are absent in *I. aculeatus*. *I. franki* can be distinguished from *I. quorna* by: only having one pair of spines on the cephalon instead of the two pairs as seen in *I. quorna*; the mandibular palp article 3 has only one pectinate seta, as opposed the many seen in *I. quorna*; pereopod 1 is more robust than in *I. quorna*, with many more sensillate robust setae present on the basis and carpus; male pleopod 1 ventral surface has less setae and male pleopod 2 stylet is short and does not hook up into the proximal half of the protopod as it does in *I. quorna*.

Distribution. From the Hikurangi Trough over the Chatham Rise to the Bounty Trough, east of New Zealand from 1586 to 2328 metres.

Etymology. This species is named after my husband Frank.

***Ilyarachna moana* n. sp. (Figs 4.34–4.36)**

Material examined.— All material from South Island, New Zealand. Holotype. Female (6.0 mm), Chatham Rise, stn S148, 44°41.0'S, 174°20.9'E, Agassiz medium trawl with fine mesh inside, 25 September 1979, 859 m, RV *Tangaroa* (NIWA XXXX). Paratypes. 3 females, 2 males and 2 fragments (1 female 5.5 mm, 1 male 5.0 mm; dissected), Chatham Rise, stn S147, 44°30.1'S, 174°18.8'E, Agassiz medium trawl with fine mesh inside, 25 October 1979, 760 m, RV *Tangaroa* (NIWA XXXX).

Additional material.— 1 female, Chatham Rise, stn S140, 44°33.9'S, 174°51.2'E, Agassiz medium trawl with fine mesh in cod end, 24 October 1979, 750 m, RV *Tangaroa* (NIWA XXXX). 2 females, 1 male, Chatham Rise, stn F753, 44°45'S, 'S, 174°30'E, Menzies trawl, 18 August 1966, 854–788 m, MV *Taranui* (NIWA XXXX). 1 female, 4 fragments, Chatham Rise, stn F755, 43°00'S, 174°30'E, Menzies trawl, 19 August 1966, 721 m, MV *Taranui* (NIWA XXXX).

Description. *Female*. Body about 2.7 times as long as greatest width of pereonite 2; widest at pereonite 2; cuticle not highly calcified, smooth. Cephalon cuticle with many robust setae; posterolateral margins broadly rounded; Pereonites 1–4 anterior margins with robust setae; pereonite 5 anterior margin smooth; anterolateral margins of pereonites all rounded except pereonites 3 and 4 which have small lobes; pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with medial spine. Pleon 1.3 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point.

Antenna 1 of 12 articles; article 1 1.4 times as long as wide, mesial margin with 1 SS, distomesial margin with 1 PNS and 1 SRS, lateral margin with 6 SS, distolateral margin with 3 SRS; article 2 cylindrical, 0.4 times as long article as 1 and 1.9 times as long as wide, mesial margin with 1 PNS, lateral margin with 1 SRS, distal margin with 2 PNS and 4 SRS; article 3 with 1 SS; article 4 with 2 PNS; articles 5, 7, 8 and 9 each with 1 SS; from article 10, each article with 1 aesthetasc; terminal article with 1 aesthetasc and 1 SS. Antenna 2

damaged; articles 1–3 more or less triangular; article 1 lateral margin with 3 SRS; article 2 1.3 times as long as article 1, distolateral margin with 2 RS; article 3 1.3 times as long as article 1, scale with 8 SRS, distomesial margin with 5 SRS; article 4 small, 1.5 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis truncate; left mandible spine row with 1 small and 8 large spines, right mandible with 1 small and 10 large spines; molar large, with 3 bi-serrate setae; mandibular palp extending beyond incisor, article 1 with 5 SS (on left mandible, right mandible with 6 SS), article 2 with 1 short pectinate seta, article 3 with 1 terminal pectinate seta. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.1 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 3 dentate RS and 6 pectinate RS, mesial lobe terminated with many SS and 2 long pectinate setae. Maxilla 2 lateral lobe surface and margins with scattered fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 1.5 times as wide as lateral lobe, margins and surface with fine SS, distally with 7 blunt SS, many fine SS, 5 toothed setae and 1 pectinate seta. Maxilliped coxa square, 1.0 times as long as wide, 0.3 times as long as basis (including endite); basis elongate, 2.7 times as long as wide (including endite), distolateral margin with 3 SS and cuticular scales; endite with 5 coupling hooks, distally with 4 toothed setae, 7 fan setae (distomesial one longest), and few fine SS; palp article 1 rectangular, 0.4 times as long as basal endite, cuticular scales present, surface with 6 SS, distomesial margin with 1 SS; article 2 2.7 times as long as and 1.3 as wide as article 1, 1.5 times as wide as basal endite, lateral margin with cuticular scales and 5 SS, surface with 2 SS, mesial margin with 4 distally pappose setae; article 3 1.4 times as long as and 1.0 times as wide as article 1, lateral margin with 1 SS, mesial margin with 2 SS and 8 distally pappose setae (at least); article 4 0.9 times as long and 0.4 as wide as article 1, mesial margin with 1 distally pappose seta; article 5 narrow, 0.8 times as long as and 0.1 times as wide as article 1, with 1 terminal pectinate seta and 1 medial distally pappose seta; epipod 1.5 times as long as wide, 1.0 times as long as basis, margins with cuticular scales and 5 SS.

Pereopod 1 basis 4.1 times as long as wide, inferior margin with 13 SRS, lateral surface with 5 SRS (on opposable surface) and 3 SS, superior margin with 8 SS; ischium 2.3 times as long as wide, inferior margin with 16 SS, lateral surface with 10 SS, superior margin with 2 SRS at mid-point and 2 SS distally; merus 0.8 times as long as wide, inferior margin with 6 SRS and 4 SS, lateral surface with 9 SS, distosuperior margin with 1 SRS and 1 SS; carpus 2.7 times as long as wide, inferior margin with 5 SS and 13 SRS, superior margin with 9 SS; propodus 4.8 times as long as wide, inferior margin with 20 SS (both marginal and sub-marginal), superior margin with 5 SS; dactylus 2.8 times as long as proximal width, superior margin with distal 3 SS.

Pereopod 2 basis 2.9 times as long as wide, inferior margin with 4 SRS and 20 SS, lateral surface with 1 PNS and 4 SS, superior margin with 3 SS and 1 SRS; ischium 2.1 times as long as wide, inferior margin with 18 SS and 1 SRS, lateral surface with 17 SS, superior margin with 2 SRS and 1 SS (all at midpoint); merus 1.3 times as long as wide, inferior margin with 10 SRS and 3 SS, lateral surface with 14 SS, distosuperior margin with 3 elongate SRS; carpus 3.5 times as long as wide, inferior margin with 2 SS and 20 SRS, lateral surface with 16 SS, superior margin with 10 SS (6 in distal clump); propodus 5.1 times as long as wide, inferior margin with 2 distal SS and 14 SRS, lateral surface with 8 SS, superior margin with 1 distal PNS and 17 SS; dactylus 6.1 times as long as proximal width, superior margin with 3 SS; unguis damaged.

Pereopod 6 basis 3.1 times as long as wide, inferior margin with 8 long SS, 15 SRS and 2 smaller SS, lateral surface with 2 PNS and 8 SS (all in superior half); ischium 3.1 times as long as wide, lateral surface with 11 SS, superior margin with 14 SS; merus 1.0 times as long as wide, inferior margin with 10 SS, distosuperior margin with 1 SS and 1 small plumose seta; carpus 1.3 times as long as wide, lateral surface with 13 SS, distosuperior margin with 1 SS; propodus 4.0 times as long as wide, lateral surface with 6 SS, distosuperior margin with 2 SS and 1 PNS; dactylus 7.5 times as long as proximal width, superior margin with 4 SS.

Pereopod 7 basis 4.6 times as long as wide, inferior margin with 4 SS, superior margin with 4 SS and 10 SRS; ischium 3.7 times as long as wide,

inferior margin with 14 SS, lateral surface with 12 SS, distosuperior margin with 1 SS; merus 1.5 times as long as wide, inferior margin with 15 SS, lateral surface with 3 SS, distosuperior margin with 1 SS; carpus 3.9 times as long as wide, lateral surface with 21 SS; propodus 8.5 times as long as wide, lateral surface with 4 SS, distosuperior margin with 1 PNS and 2 SS; dactylus 7.3 times as long as proximal width, distosuperior with 4 SS.

Operculum 1.9 times as long as proximal width, medial keel with row of RS and SS, distally with numerous scattered SS, medial excision and veined lamellar extension, margins anterolaterally with 18 SS, laterally with numerous plumose setae. Pleopod 3 exopod, 1.2 times as long as endopod, distally with 9 long plumose setae and 1 SS; endopod 2.1 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 5 terminal long plumose setae; endopod oval, 1.8 times as long as wide. Pleopod 5 2.4 times as long as wide.

Uropod protopod 2.5 times as long as wide, sub-rectangular, margins with cuticular scales, lateral margin with row of plumose setae (although only sockets remaining), distal margin with at least 4 robust plumose setae, mesial margin with 3 plumose setae, surface with 2 SS; exopod rudimentary, with 3 setae; endopod 0.3 times as long as protopod, with at least 3 setae.

Male. Antenna 1 of 30 articles; article 1 1.4 times as long as wide, lateral margin with 7 SS, 1 SRS and 2 PNS, distolateral margin with 1 PNS and 1 SRS, distomesial margin with 3 SRS and 1 PNS; article 2 1.4 times as long as wide, mesial margin with 1 SS, lateral margin with 1 SRS, distal margin with 3 SRS, 1 SS and 1 PNS; article 3 with 4 small SS; article 4 with 2 PNS; articles 7–9 with 1 SS; from article 10 onwards, each article with 1 aesthetasc and several with an additional seta; terminal article with 1 SS and 1 aesthetasc.

Pleopod 1 4.2 times as long as proximal width, lateral margins indent 0.6 from proximal end, lateral margins with 16 SS (7 + 9), either side of central margin with 24 SS (8 RS and 4 SS on each side), distally with 27 SS (13+14). Male pleopod 2 protopod 3.8 times as long as wide, lateral margin with 4 SS (at least), and row of plumose setae, surface with 1 SS, distally with lamellar extension, mesial margin with 3 plumose setae and 3 SS; exopod hooked, 0.1 times as long as protopod, with fine SS; stylet 0.4 times as long as protopod, not

hooking up into proximal half of protopod, terminating to a rounded point; sperm duct 0.4 times as long as stylet.

Remarks. *Ilyarachna moana* n. sp. belongs to the group of *Ilyarachna* which have robust setae on the cephalon and on the anterior margins of pereonites 1–4. This species is distinguished by the combination of: the numerous robust setae on the cephalon; the multiple sensillate robust setae on the anterolateral margin of antenna 1 article 1; the numerous sensillate robust setae on the inferior margin o the basis and carpus; and the short stylet of the male pleopod 2. *I. moana* is most similar to *Ilyarachna nordenstami* and *Ilyarachna crozetensis*. *I. moana* can be distinguished both species by the short stylet of male pleopod 2 which does not hook up into the protopod. *I. moana* can be further distinguished from *I. nordenstami* by antenna 1 lateral margin with row of simple setae, not robust setae as in *I. nordenstami* and by the sensillate robust setae seen on the inferior margin of the basis and carpus, which is not present in *I. nordenstami*. *I. moana* can be distinguished from *I. crozetensis* by lack of fine simple setae on the anterior margin of pereonite 5 and the presence of a biramous uropod.

Distribution. *I. moana* is known from the Chatham Rise, east of the South Island of New Zealand, from a depth range between 721–859 m.

Etymology. Moana is a Māori (and Polynesian) word meaning the sea or ocean; noun in apposition.

Ilyarachna mokari n. sp. (Figs 4.37–4.39)

Material examined.— All material is from Victoria, Australia. Holotype. Male (3.0 mm), 67 km south of Point Hicks stn SLOPE 67, from 38°23.95'–23.78'S, 149°17.02'–15.24'E, 25 October 1988, WHOI epibenthic sled, RV *Franklin*, 1277-1119 m, fine mud, (ex NMV J18873). Paratypes. 2 females, 1 male (3.0 mm, partially dissected), 2 fragments, type locality (ex NMV J18873). 2 females (1 female, 4.0 mm, dissected), 1 male, 6 fragments, south of Point Hicks, stn SLOPE 33, 38°19.60'S, 149°24.30'E, 23 July 1986, WHOI epibenthic sled, 930 m, RV *Franklin*, rock, rubble, clay, sand (NMV J18871).

Additional material.— 1 male, 1 female, 1 fragment, south of Point Hicks, stn SLOPE 34, 38°16.40'S, 149°27.60'E, 23 July 1986, WHOI epibenthic sled, 800 m, RV *Franklin*, coarse shell, biogenic sediments (NMV J18872). 1 female, 1 male, 17 fragments, south of Point Hicks, stn SLOPE 32, 38°21.90'S, 149°20.0'E, 23 July 1986, WHOI epibenthic sled, 1000 m, RV *Franklin* (NMV J18870).

Description. Male. Body about 2.2 times as long as greatest width of pereonite 2; widest at pereonite 2; cuticle not highly calcified and lightly setose. Cephalon lightly setose, spines absent; posterolateral margins broadly rounded; Pereonites 1–4 anterior margins with robust setae, pereonite 5 anterior margin smooth; anterolateral margins of pereonites all rounded except pereonites 3 and 4 which have small anterolateral lobes; pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with medial spine. Pleon 1.3 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point, with few scattered SS.

Antenna 1 of 25 articles; articles 1 and 2 ratios similar to female; article 1 with 2 PNS and 1 SS, distally with 2 RS; article 2 with 1 PNS on ventral surface, distal end with 5 PNS and 3 RS; article 4 with 1 PNS; article 5 with 1 SS; from article 6 onwards, each article has 1 aesthetasc and many articles with additional setae; terminal article with 2 SS and an aesthetasc.

Pleopod 1 12.1 times as long as proximal height, lateral margins indent 0.2 from proximal end, either side of ventral margin with 7 SRS and 15 SS, distally with 24 SS (14+10). Pleopod 2 protopod 3.1 times as long as wide, lateral margin with 2 SS (in proximal half) and 9 plumose setae (most likely plumose setae, only sockets remain), distally with lamellar extension and few fine SS, mesial margin with 5 plumose setae; exopod hooked, 0.2 times as long as protopod, with fine SS; stylet long, 1.6 times as long as protopod, hooked up into proximal part of protopod, terminating to a point; sperm duct 0.7 times as long as stylet.

Female. Antenna 1 of 10 articles; article 1 elongate, 1.2 times as long as wide, surface with 3 PNS, lateral margin with 1 SS and 2 SRS, distal margin with

2 SRS; article 2 0.5 times as long article 1, 2.5 times as long as wide, distal rim with 5 4 SRS and 1 PNS; article 4 with 1 PNS; article 5 with 4 SS; article 6 with 2 SS; from article 7, each article has 1 aesthetasc, many articles with additional setae; terminal article with 2 SS, 1 PNS and an aesthetasc. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 lateral margin with 3 SRS; article 2 0.8 times as long as article 1, with no setae; article 3 1.2 times as long as article 1, scale with 3 SRS and 1 SS, distomesial margin with 2 SRS; article 4 small, 0.8 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis reduced and smooth, rounded; spine row with 9 spines (on left mandible, 8 on right); molar with 3 bi-serrate setae; mandibular palp extending beyond incisor, article 1 with 4 SS (on left mandible; 3 SS on right), article 3 with 1 long SS and 1 long pectinate setae. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.7 times as wide as mesial lobe, distal margin with few fine SS, 5 RS, 2 dentate RS and 5 pectinate RS, mesial lobe distally with many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.6 times as wide as lateral lobe, margins and surface with fine SS, proximally, mesial margin also with 7 long SS, distally with 9 blunt SS, 4 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, 1.1 times as long as wide, 0.4 times as long as basis (including endite); basis elongate, 2.8 times as long as wide (including endite), with 2 SS; endite with 6 coupling hooks, distally with 3 toothed setae, 7 fan setae and few fine SS; palp article 1 sub-rectangular, 0.4 times as long as basal endite, cuticular scales present, distolateral margin with 1 SS, surface with 1 SS, distomesial margin with 1 SS; article 2 2.8 times as long as 1.2 times as wide as article 1, 1.5 times as wide as basal endite, lateral margin with cuticular scales and 3 RS, surface with 1 distally pappose seta and 3 SS, mesial margin with 5 distally pappose setae; article 3 1.3 times as long as and 0.9 times as wide as article 1, lateral margin with 1 RS, surface with 4 distally pappose setae, mesial margin with 14 distally pappose setae; article 4 0.8 times as long as and 0.3 as wide as article 1, mesial margin with 8 distally pappose setae; article 5 narrow, 0.9 times as long as and 0.1 times as wide as article 1,

with 4 distally pappose setae and 1 SS; epipod 1.6 times as long as wide, 1.1 times as long as basis, margins with cuticular scales and few scattered SS.

Pereopod 1 basis 3.9 times as long as wide, inferior margin with 9 SRS, superior margin with 1 SRS, 2 PNS and 6 SS; ischium 2.7 times as long as wide, inferior margin with 4 SS, lateral surface with 5 SS, superior margin with 4 long RS; merus 0.9 times as long as wide, inferior margin with 9 SS, distosuperior margin with 1 SS and 1 RS; carpus 4.1 times as long as wide, inferior margin with 10 SS, distosuperior margin with 1 SS; propodus 6.1 times as long as wide, inferior margin with 12 SS (in distal half), superior margin with 9 SS (in distal half); dactylus 3.1 times as long as proximal width, superior margin with 4 small SS.

Pereopod 2 basis 2.4 times as long as wide, inferior margin with 9 SS and 4 SRS, lateral surface with 1 SS, superior margin with 8 SS; ischium 2.1 times as long as wide, inferior margin with 2 SS and 13 SRS, lateral surface with 2 distal SRS and 6 SS, superior margin with 7 SRS (lengths varying); merus 1.5 times as long as wide, inferior margin with 11 SRS, lateral surface with 4 SRS, superior margin with 3 SS, distosuperior corner with 3 SRS and 1 SS; carpus 5.8 times as long as wide, inferior margin with 14 SRS, lateral surface with 8 SRS and 1 SS, superior margin with at least 4 SRS and 3 SS, distosuperior corner with 2 SRS, 1 PNS and 1 SS; propodus 9.4 times as long as wide, inferior margin with 12 evenly spaced SRS and 3 distal SS, lateral surface with 6 SS, superior margin with 13 SS, distosuperior corner with 1 PNS; dactylus 9.7 times as long as proximal width, with 5 SS.

Pereopod 5 basis 4.6 times as long as wide, inferior margin with 2 SRS, 2 RS and 7 SS, lateral surface with 8 RS, superior margin with 1 SS (at mid-point); ischium 2.5 times as long as wide, inferior margin with 8 SS and 1 RS, lateral surface with 7 SS; merus 1.0 times as long as wide, inferior margin with 10 SS, distosuperior margin with 2 SS; carpus 1.3 times as long as wide, lateral surface with 3 SS, distosuperior margin with 1 SS; propodus 3.2 times as long as wide, distoinferior margin with 1 sub-marginal SS, lateral surface with 4 SS, distosuperior margin with 1 RS; dactylus 6.3 times as long as proximal width, with 9 SS (in superior half).

Operculum 1.8 times as long as proximal width, medial keel provided with row of RS, proximally with 1 SS, distally surface with few scattered setae, medial excision and veined lamellar extension, margins anterolaterally with 8 SS (5+3), laterally with numerous plumose setae. Pleopod 3 exopod 1.3 times as long as endopod, distally with 6 long plumose setae and 1 SS; endopod 1.9 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 3 terminal long plumose setae; endopod oval, 1.7 times as long as wide. Pleopod 5 1.9 times as long as wide.

Uropods missing.

Remarks. *Ilyarachna mokari* n. sp. is distinguished by a combination of: a smooth cephalon; pereonites 1–4 anterior margins with robust setae; pereonite 5 with no lateral indentation; ventrally, only pereonite 7 with ornamentation; male antenna 1 long, of about 25 articles, article 3 two-thirds length of article 2; and pereopod 1 basis inferior margin with row of evenly spaced robust setae. It is most similar to *Ilyarachna flindersi* and for further discussion, refer to the remarks section for *I. flindersi.*

Distribution. South of Point Hicks, Victoria, Australia, between 800–1277 metres.

Etymology. Mokari is an Aboriginal word for new; noun in apposition

***Ilyarachna pacifica* n. sp. (Figs 4.40–4.42)**

Material examined.— Holotype. Male (6.0 mm), northeast slope, North Island, New Zealand, stn F892, 36°58.5’S, 176°41’E, Agassiz medium trawl, 5 October 1968, 1278–1144 m, MV *Taranui* (NIWA XXXX). Paratypes. 1 female (5.0 mm, dissected), 1 male (anterior half, 3.5 mm, dissected), 1 male (posterior half, 4.0 mm, dissected), type locality (NIWA XXXX).

Description. Male. Body about 3.0 times as long as greatest width (from lobe tip to lobe tip) of pereonite 2; widest at pereonite 4; cuticle not highly calcified, smooth. Cephalon with 2 pairs of spines and 1 additional spine on left, laterally with 3 pairs of small spines, 1 additional spine on left; posterolateral

margins broadly rounded; Pereonite 1 anterior margin with 3 spines; pereonites 2–4 with 5 spines; pereonite 5 with pair of spines and pair of small protrusions; pereonite 4 laterally with additional spine on left; pereonites 4–6 each with pair of dorsal spines. Anterolateral margins of pereonites 1–4, 6 and 7 with lobes; pereonite 5 anterolateral margin square. Pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with two small spines. Pleon 1.0 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point.

Antenna 1 of 36 articles; article 1 elongate, 1.8 times as long as wide, surface with 6 SRS and 1 PNS, lateral margin with 5 SRS, distal margin with 1 PNS and 6 SRS; article 2 0.5 times as long article 1, 3.0 times as long as wide, with 7 SRS (all in distal half); article 3 lateral margin with 2 SS, surface with 1 SRS, mesial margin with 4 SS; article 4 mesial margin with 2 PNS; article 6 with 1 SS; from article 8, each article has 1 aesthetasc, some articles with additional SS; terminal article with 2 SS. Antenna 2 damaged, articles 1–3 more or less triangular; article 1 lateral margin with 8 SRS; article 2 1.2 times as long as article 1, distolateral margin with 3 SRS; article 3 1.7 times as long as article 1, scale with 6 SRS, distomesial margin with 2 SRS; article 4 slightly elongate, 1.4 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis reduced and truncate; spine row with 14 spines (on left mandible, 16 on right); molar small, with 3 bi-serrate setae; mandibular palp not extending beyond incisor, article 1 with 5 SS (on left mandible and 7 on right), article 3 with 1 SS and 1 pectinate seta (on left mandible, 1 pectinate seta on right). Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.8 times as wide as mesial lobe, distal margin with few fine SS, 4 RS (1 broken), 7 dentate RS and 1 pectinate RS, mesial lobe distally with many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins and surface with scattered fine SS distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.5 times as wide as lateral lobe, margins and surface with fine SS, proximally, mesial margin also with 5 long bi-serrate setae, distally with 11 blunt SS, 7 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, 0.6 times as long as wide, 0.2 times as long as basis

(including endite); basis elongate, 2.6 times as long as wide (including endite), surface with 3 SS, lateral margin with 1 SS, distolateral margin with 3 SS; endite with 7 coupling hooks, distally with 7 bi-serrate setae and 9 fan setae (distomesial one is longest); palp article 1 trapezoid, 0.4 times as long as basal endite, distolateral margin with 1 SS, surface with 4 SS, distomesial margin with 2 SS; article 2 2.8 times as long as and 1.5 as wide as article 1, 1.7 times as wide as basal endite, lateral margin with 10 SS surface with 5 SS and 1 distally pappose seta, mesial margin with 4 distally pappose setae; article 3 1.3 times as long as and 1.1 times as wide as article 1, lateral margin with 3 SS, surface with 3 SS, mesial margin with 2 SS and at least 7 distally pappose setae; article 4 0.9 times as long as and 0.4 as wide as article 1, lateral margin with 4 SS, surface with 4 SS and 6 distally pappose setae; article 5 narrow, 0.8 times as long as and 0.2 times as wide as article 1, with 8 terminal distally pappose setae; epipod 1.5 times as long as wide, 2.6 times as long as basis, margins with cuticular scales and 4 SS.

Pleopod 1 3.7 times as long as proximal width, lateral margins indent 0.6 from proximal end, either side of central margin with 18 RS (9+9) and 20 SS (6+14), distally with 30 SS (16+14). Pleopod 2 protopod 2.7 times as long as wide, lateral margin with row of plumose setae (setae towards proximal margin have fine short setules), distally with lamellar extension, mesial margin with 2 SS and 3 plumose setae; exopod hooked, 0.1 times as long as protopod with fine SS; stylet short,; 0.6 times as long as protopod, not hooking up into proximal part of protopod, terminating to a point; sperm duct 0.5 times as long as stylet. Pleopod 3 exopod 1.1 times length of endopod, distally with 8 long plumose setae and 1 SS; endopod 2.1 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 5 terminal long plumose setae; endopod oval, 1.8 times as long as wide. Pleopod 5 2.2 times as long as wide.

Uropod protopod 1.9 times as long as wide, oval, distal end rounded, margins with cuticular scales, lateral margin with 18 SS and row of plumose setae (damaged), distal margin with 15 short plumose setae, surface with 5 scattered plumose setae; exopod rudimentary, 0.1 times as long as protopod, 0.2

times as long as endopod, with 3 SS; endopod 0.3 times as long as protopod, with 3 SS and 7 PNS.

Female. Antenna 1 of 11 articles; article 1 1.4 times as long as wide, , mesial margin with 1 SS, distomesial margin with 2 SRS and 1 PNS, surface with 2 SRS and 2 PNS, lateral margin with 4 SRS, distolateral margin with 3 SRS and 1 PNS; article 2 2.6 times as long as wide, lateral margin with 1 SRS distal margin with 4 SRS; article 3 with 3 SS; article 4 with 2 PNS; article 5–7 with SS; from article 8 onwards, each article has 1 aesthetasc and many articles have additional SS; terminal article with 1 PNS, 2 SS and 1 aesthetasc).

Operculum 3.0 times as long as proximal width, medial keel with row of RS, proximally with 1 SS, distal surface with 2 plumose setae (at least, distal end damaged), and few SS, medial excision and veined lamellar extension, margins anterolaterally with 5 SS (3+2 SS, at least), laterally with numerous plumose setae.

Remarks. *Ilyarachna pacifica* n. sp. has a unique dorsal spine pattern with dorsal spines present on all the anterior margins of pereonites 1–5 and non-marginal spines present on pereonite 6. This pattern differs from similar spiny species, such as *Ilyarachna taratara* which has no spines on pereonites 5 or 6 and *Ilyarachna taranui* which has no dorsal spines on pereonites 1 and 3.

Distribution. Known only from type locality, the north-eastern slope of the North Island, New Zealand, between the depths of 1144–1278 metres.

Etymology. *I. pacifica* is named after the Pacific Ocean.

***Ilyarachna quorna* n. sp. (Figs 4.43–4.45)**

Material examined.— Holotype. Female (4.4 mm), 76 km S of Point Hicks, Victoria, Australia, stn SLOPE 69, from 38°29.33'–26.81'S, 149°19.98'–20.78'E, 26 October 1988, WHOI epibenthic sled, 1840–1750 m, RV *Franklin*, sandy mud, fine shell (ex NMV J18862). Paratypes. 1 male (4.0 mm, dissected) 1 female, type locality, (ex NMV J18862).

Description. Female. Body about 2.9 times as long as greatest width of pereonite 2; widest at pereonite 3; cuticle not highly calcified, lightly setose. Cephalon lightly setose, with dorsal 4 spines; posterolateral margins broadly rounded. Pereonites 1–4 anterior margins with RS; pereonite 5 anterior margin smooth, laterally with small indentation; anterolateral margins of pereonites all rounded except pereonites 3, 4, 6 and 7 which have small lobes; pereonites 6 and 7 each ventrally with medial spine. Pleon 1.4 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point, with scattered SS.

Antenna 1of 9 articles; length 1.4 times as long as wide, article 1 lateral margin with 4 PNS and 4 SS, surface with 3 SS (all on other side), mesial margin with 2 SS, distal margin with 4 PNS and 4 SRS; article 2 2.9 times as long as wide, 1 broken seta and 1 PNS at midpoint, distally with 2 PNS and 1 SRS; article 3 with 1 SS; article 4 with 2 PNS; article 5 with 1 SS; article 6 with 2 SS; from article 7 onwards, each article has 1 aesthetasc and many with additional setae; terminal article with 2 SS and 1 aesthetasc.

Operculum 2.5 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with row of RS, distal surface with numerous scattered SS, margins anterolaterally with 30 SS (14+16), laterally with numerous plumose setae.

Male. Antenna 1 damaged; article 1 1.4 times as long as wide, mesial margin with 2 RS, surface with 1 PNS and 2 RS, lateral margin with 5 SS and 1 RS, each distal corner with 1 SRS and 1 PNS; article 2 0.6 times as long as article 1, 1.8 times as long as wide, inferior margin with 1 RS, surface with 1 SS, superior margin with 1 PNS, distal margin with 1 PNS. Antenna 2 damaged, articles 1–3 more or less triangular; article 1 lateral margin with 1 RS and 1 SS; article 2 approximately 0.9 times as long as article 1, distolateral margin with 1 SS; article 3 1.3 times as long as article 1, scale with 3 RS; article 4 small, 0.7 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis reduced, truncate, with 2 small cusps; spine row with 9 spines; molar large, with 3 bi-serrate setae; mandibular palp extending beyond incisor, article 1 with 5 SS (on left, 6 on right), and cuticular scales,

article 3 with 6 pectinate setae (on left mandible; right mandible with 7 pectinate setae) and cuticular scales. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.6 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 3 dentate RS and 6 pectinate RS, mesial lobe distally with 1 SS, many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.3 times as wide as lateral lobe, margins and surface with fine SS proximally, mesial margin also with 7 long SS, distally with 9 blunt SS, 6 bi-serrate setae and 1 long pectinate seta. Maxilliped coxa square, 1.0 times as long as wide, and 0.4 times as long as basis (including endite); basis rectangular, 2.8 times as long as wide (including endite), with 5 SS; endite with 4 coupling hooks, and distally with 3 blunt SS, 7 fan setae, and many fine SS; palp article 1 sub-rectangular, 0.4 times as long as basal endite, with cuticular scales, surface with 1 SS, distomesial margin with 1 SS; article 2 2.6 times as long as and 1.4 as wide as article 1, 1.4 times as wide as basal endite, with lateral margin with cuticular scales and 5 SS, surface with 1 distally pappose seta, mesial margin with 3 distally pappose setae; article 3 1.3 times as long as and 1.1 times as wide as article 1, lateral margin with 1 SS surface with 3 SS, mesial margin with 13 distally pappose setae and 1 SS; article 4 0.8 times as long as and 0.6 as wide as article 1, lateral margin with 1 SS and 7 distally pappose setae (on inferior margin); article 5 narrow, 0.8 times as long as and 0.2 times as wide as article 1 with 2 SS, 1 pectinate seta and 4 distally pappose setae; epipod approximately 1.4 times as long as wide, 1.1 times as long as basis, margins with many cuticular scales.

Pereopod 1 basis 5.9 times as long as wide, inferior margin with 8 SRS, lateral surface with 3 SRS (in distal half), superior margin with 9 SS (4 sub-marginal) and 2 PNS; ischium 4.6 times as long as wide, inferior margin with 4 SS, superior margin with 3 SS and 2 long SRS; merus 1.4 times as long as wide, inferior margin with 8 SS, distosuperior margin with 2 SS; carpus 4.9 times as long as wide, inferior margin with 4 SRS and 20 SS (of varying lengths), distosuperior margin with 1 SS; propodus 7.8 times as long as wide, inferior and

superior margins with numerous SS; dactylus 2.1 times as long as proximal width, superior margin with 3 SS (in clump, in distal half).

Pleopod 1 11.1 times as long as proximal height, lateral margins indent 0.2 from proximal end, with 7 SS (4+3), ventral surface with 40 RS (robustness of setae reducing towards distal end), distally with 25 SS (10+15). Pleopod 2 protopod 3.5 times as long as wide, lateral margin with 7 SS (in proximal half) and row of plumose setae, surface with 2 SS and 1 plumose seta, distally with lamellar extension, mesial margin with 4 plumose setae; exopod hooked, 0.2 times as long as protopod with fine SS; stylet elongate, 1.5 times as long as protopod, hooking up into proximal half of protopod; sperm duct 0.7 times as long as stylet. Pleopod 3 exopod 1.4 times length of endopod, distally with 8 long plumose setae (counted from sockets) and 1 SS; endopod 2.2 times as long as wide, with 3 long plumose setae (counted from sockets). Pleopod 4 exopod with 5 terminal long plumose setae; endopod oval, 1.8 times as long as wide. Pleopod 5 2.3 times as long as wide.

Remarks. *Ilyarachna quorna* n. sp. is distinguished by the combination of: two pairs of dorsal spines on the cephalon; mandibular palp article 3 distally with multiple pectinate setae; pereopod 1 basis inferior margin with an evenly spread row of robust setae; male pleopod 1 ventral surface with many elongate setae; and male pleopod 2 stylet elongate and hooks up into proximal half. For discussion distinguishing *I. quorna* from the species it is most similar to, refer to the comments for *I. franki*.

Distribution. Known only from the type locality, 76 km S of Point Hicks, Victoria, Australia, between the depths of 1750–1840 metres.

Etymology. Quorna is an Aboriginal word for deep; noun in apposition.

Ilyarachna taranui n. sp. (Figs 4.46–4.47)

Material examined.— All material from North Island, New Zealand. Holotype. Male (4.0 mm), north-west slope, stn E882, 36°00’S, 172°42’E, Agassiz medium trawl, 22 March 1968, 1217 m, MV *Taranui* (NIWA XXXX). Paratypes. 1 male (4.0 mm, dissected), 4 fragments, type locality (NIWA XXXX).

Additional material.— 1 male, north-west slope, stn E901, 38°00'S, 173°19'E, Agassiz medium trawl, 25–26 March 1968, 1247–1250 m, MV *Taranui* (NIWA XXXX). 1 male, Challenger Plateau, stn P928, 40°46.0'S, 167°54.9'E, epibenthic sled, 18 April 1980, 1029–1028 m, RV *Tangaroa* (NIWA XXXX).

Description. Body about 3.1 times as long as greatest width of pereonite 2 (from spine tip to spine tip); widest at pereonite 2; cuticle not highly calcified, smooth. Cephalon with 2 dorsal spines and pair of anterolateral spines; posterolateral margins rounded. Pereonites 1 and 3 anterior margins without spines, pereonites 2 and 4 each with pair of spines; pereonites 1–2 with pair of anterolateral spines; pereonite 5 anterior margin with pair of spines, pereonites 6 and 7 with pair of dorsal spines; anterolateral margins of pereonites 1 and 2 rounded, 3 and 4 with small lobes, 5 square and 6 and 7 with small lobes; pereonite 6 ventrally without ornamentation; pereonite 7 ventrally with medial ridge with pair of long setae. Pleon 1.3 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point.

Antenna 1damaged; article 1 1.1 times as long as wide, mesial margin with 3 PNS, lateral margin with 2 SRS and 1 PNS, distal margin with 1 PNS; article 2 0.7 times as long as article 1, 1.9 times as long as wide, lateral margin with 1 SS, distomesial margin with 1 PNS; article 4 lateral margin with 2 PNS; article 6 with 1 SS; from article 7, each article has 1 aesthetasc, many articles with additional setae. Antenna 2 damaged, articles 1–3 more or less triangular; article 1 lateral margin with 1 RS on short distolateral extension; article 2 1.1 times as long as article 1, distolateral margin with 1 RS; article 3 1.4 times as long as article 1, scale with 2 RS and 1 SS, distomesial margin with 1 RS; article 4 1.3 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis reduced with distal point; spine row with 5 spines; molar small, distally with 2 uni-serrate setae (on left mandible, 3 on right mandible); mandibular palp extending beyond incisor, article 2 with 1 pectinate seta (on left mandibular palp, right mandibular palp with 2 pectinate setae and cuticular scales, article 3 with cuticular scales and 7 setae (on right mandible, unable to tell what type; setae present on article 3 on left mandible, but unable to determine number). Maxilla 1 lateral and mesial margins with fine SS; lateral

lobe 1.9 times as wide as mesial lobe, distal margin with few fine SS, 8 RS, 2 dentate RS and 2 pectinate RS, mesial lobe distally with 5 SS, many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.8 times as wide as lateral lobe, margins and surface with fine SS, proximally, mesial margin also with 16 long SS, distally with 5 blunt SS, many fine SS, 5 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, 1.3 times as long as wide, 0.4 times as long as basis (including endite); basis elongate, 2.8 times as long as wide (including endite); endite with 4 coupling hooks, distally with 3 SS, 6 fan setae (distomesial one is longest) and many fine SS; palp article 1 sub-rectangular, 0.4 times as long as basal endite, cuticular scales present, distomesial margin with 1 SS; article 2 2.6 times as long as and 1.2 as wide as article 1, 1.1 times as wide as basal endite, lateral margin with 6 RS, mesial margin with 2 distally pappose setae and 1 SS; article 3 1.3 times as long as and 1.0 times as wide as article 1, lateral margin with 1 RS, mesial margin with at least 5 distally pappose setae; article 4 0.8 times as long as and 0.5 as wide as article 1, lateral margin with 1 SS, distomesial margin with 7 SS; article 5 narrow, 0.8 times as long as and 0.2 times as wide as article 1, with 7 terminal SS; epipod 1.3 times as long as wide, 1.0 times as long as basis, margins with cuticular scales and surface with 4 scattered SS.

Pleopod 1 10.2 times as long as proximal height, lateral margins indent 0.4 from proximal end, ventral surface with 17 RS, distally with 13 SS (7+6). Pleopod 2 protopod 3.5 times as long as wide, lateral margin with 10 SS (proximal end) and row of plumose setae, surface with 11 scattered SS, distally with lamellar extension, mesial margin with 5 plumose setae (not as setose as ones on lateral margin) and 3 SS; exopod hooked, 0.2 times as long as protopod with fine SS; stylet long, 1.3 times as long as protopod, hooked up into proximal half of protopod; sperm duct 0.6 times as long as stylet. Pleopod 5 approximately 1.9 times as long as wide.

Uropod protopod 1.8 times as long as wide, oval, distal end rounded, margins with cuticular scales, lateral margin with 1 plumose seta, 10 SS and 8

sockets (possibly where plumose setae were), distal margin with 6 plumose setae, surface with 1 plumose seta; exopod small, 0.1 times as long as protopod, 0.2 times as long as endopod, with 2 SS; endopod 0.3 times as long as protopod, with 6 SS and 5 PNS.

Females are not known for this species.

Remarks. *Ilyarachna taranui* n. sp. is easily identified by the dorsal spines only present on pereonites 2 and 4 and absent on pereonites 1 and 3. Such a pattern is unique and not known from any other species in this genus.

Distribution. *I. taranui* is known from west of the North Island of New Zealand, from the north-west slope to the Challenger Plateau, between 1028–1250 metres.

Etymology. *I. taranui* is named after the ship, the MV *Taranui* which collected the type material; noun in apposition.

***Ilyarachna taratara* n. sp. (Figs 4.48–4.50)**

Material examined.— All material from Bounty Trough, South Island, New Zealand. Holotype. Male (6.0 mm), stn S151, 45°45.8'S, 174°30.5'E, epibenthic sled, 26 September 1979, 1586 m, RV *Tangaroa* (NIWA XXXX). Paratypes. 8 females (6.5 mm, dissected), 1 male, stn S153, 45°21.1'S, 173°35.8'E, epibenthic sled, 27 September 1979, 1386 m, RV *Tangaroa* (NIWA XXXX).
Additional material.— 2 females, stn S154, 45°24.2'S, 173°59.8'E, epibenthic sled, 27 September 1979, 1373 m, RV *Tangaroa* (NIWA XXXX).

Description. *Male*. Body about 2.7 times as long as greatest width (from lobe tip to lobe tip) of pereonite 2; widest at pereonite 5; cuticle calcified, smooth. Cephalon with 4 pairs of dorsal spines and 3 pairs of small lateral spines; posterolateral margins broadly rounded. Pereonites 1 and 2 anterior margins with 5 small spines, pereonites 3 and 4 with 4 spines, pereonite 5 anterior margin smooth; anterolateral margins of pereonites 1–4 with lobes, 5 square, 6 and 7 rounded; pereonite 6 ventrally with no ornamentation; pereonite

7 ventrally with medial ridge with many setae. Pleon 1.1 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point.

Male pleopod 1 3.6 times as long as proximal width, lateral margins indent 0.5 from proximal end, ventral surface with 37 RS (17 + 20), distally with 17 SS (8+9). Male pleopod 2 protopod 3.1 times as long as wide, lateral margin with 16 SS (all in proximal half) and row of plumose setae, surface with 11 SS (2 at proximal end, 7 distally all in row), distally with lamellar extension, mesial margin 1 SS and 5 plumose setae; exopod hooked, 0.2 times as long as protopod with fine SS; stylet 0.7 times as long as protopod, does not hook up into proximal part of protopod; sperm duct 0.6 times as long as stylet.

Female. Antenna 1 damaged; article 1 1.4 times as long as wide, mesial margin with 1 SS, distomesial margin with 1 SRS, surface with 4 PNS and 6 SRS, lateral margin with 7 evenly spaced SRS, distolateral corner with 4 SRS and 1 PNS in clump; article 2 0.4 times as long as article 1, 2.8 times as long as wide, with 6 SRS and 1 PNS (in distal half); article 3 (damaged) with 2 SS. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 lateral margin with 4 RS; article 2 1.1 times as long as article 1, distolateral margin with 2 RS; article 3 1.2 times as long as article 1, scale with 3 RS and 1 SS, distomesial margin with 6 SRS (in a clump); article 4 small, 1.0 times as long as article 1, with no ornamentation.

Mandible without cuticular scales; lacinia mobilis smooth, square; spine row with 13 spines; molar small, with 4 bi-serrate setae; mandibular palp small, not extending beyond incisor, article 1 with 3 SS (right mandibular palp with 5 SS), article 3 with 1 elongate pectinate seta. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.5 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 5 dentate RS and 4 pectinate RS, mesial lobe distally with 4 SS, many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.5 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 3.6 times as wide as lateral lobe, margins and surface with fine SS, proximally, mesial margin also with 6 bi-serrate setae, distally with 11 blunt SS, 7 toothed setae and 1 pectinate seta. Maxilliped coxa damaged; basis elongate, 2.7 times as long as wide (including

endite), with 7 SS (3 on distolateral corner); endite with 8 coupling hooks, distally with 6 uniserrate setae, 9 fan setae and many fine SS; palp article 1 sub-rectangular, 0.4 times as long as basal endite, distolateral margin with 1 SS, surface with 4 SS, distomesial margin with 2 SS; article 2 3.5 times as long as and 1.2 as wide as article 1, 1.4 times as wide as basal endite, lateral margin with 4 SS (2 more robust than others), surface with 1 distally pappose seta and 3 SS, mesial margin with 5 distally pappose setae; article 3 2.0 times as long as and 0.9 times as wide as article 1, lateral margin with 3 SS, surface with 7 SS, mesial margin with 5 SS and 18 distally pappose setae; article 4 1.1 times as long as and 0.3 times as wide as article 1, lateral margin with 2 SS, distal margin with 2 SS and 5 distally pappose setae; article 5 narrow, 1.0 times as long as and 0.1 times as wide as article 1, with 7 terminal distally pappose setae; epipod 1.5 times as long as wide, 1.0 times as long as basis, margins with many cuticular scales, and 8 SS (5 on lateral margin, 3 on proximal surface).

Pereopod 1 basis 4.0 times as long as wide, inferior margin with 8 SRS (in distal half), lateral surface with 3 SS (in distal half, towards superior margin); ischium 2.4 times as long as wide, inferior margin with 12 SS, lateral surface with 4 RS and 6 SS, superior margin with 2 RS; merus 1.0 times as long as wide, inferior margin with 23 SS, lateral surface with 13 scattered SS, distosuperior margin with 2 RS and 2 SS; carpus 3.1 times as long as wide, inferior margin with 45 SS, lateral surface with 4 SS, superior margin with 10 SS; propodus 5.7 times as long as wide, inferior margin with 19 SS, lateral surface with 12 SS, superior margin with 25 SS; dactylus 2.5 times as long as proximal width, superior margin with 4 small SS (in distal clump).

Operculum 2.1 times as long as proximal width, medial keel provided with row of SRS, distally with numerous SS, proximally with 6 long SRS, distally with 1 plumose seta, medial excision and veined lamellar extension, margins anterolaterally with 27 SS (11 + 16), laterally with numerous plumose setae. Pleopod 3 exopod 1.2 times as long as endopod, distally with 12 long plumose setae and with 1 SS; endopod 2.0 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 6 terminal long plumose setae; endopod oval, 1.8 times as long as wide. Pleopod 5 2.0 times as long as wide.

Uropod protopod 1.9 times as long as wide, distal end rounded, lateral margin with 20 plumose setae and 13 SS, distal margin with 12 robust plumose setae, surface with 6 scattered plumose setae; exopod rudimentary, with 4 setae (at least 2 are SS); endopod 0.3 times as long as protopod, with 2 setae (type unknown, distal end of endopod damaged).

Remarks. *Ilyarachna taratara* n. sp. is most easily distinguished by the numerous spines on the cephalon and anterior margins of pereonites 1–4; the lack of dorsal spines on pereonites 4 and 5–7. *I. taratara* most closely resembles *I. pacifica*, but is distinguishable by: the absence of spines on pereonites 5–7; the presence on additional robust setae on the lateral margin and dorsal surface of antenna 1 article 1; and the ventral side of pereonite 7 with a medial row of setae and not with a pair of spines as seen in *I. pacifica*.

Distribution. Bounty Trough, South Island, New Zealand, between 1373–1586 metres.

Etymology. Taratara is a Māori word meaning spine, alluding to the dorsal spines on the body; noun in apposition.

***Notopais* Hodgson, 1910**

Notopais Hodgson, 1910: 69.— Merrin, 2004: 3–4.

Type species. *Notopais spicatus* Hodgson, 1910, by monotypy.

Diagnosis. Cephalic frons wide, rectangular; cephalic anterior flanges present, small Pereonites 1–4 anterior margins usually with spines, if not, margins with short stiff setae; all spines tipped with robust (pedestal) setae, making spines look more pronounced; pereonites 5–7 lateral margins not narrow; natasome streamlined, not reduced. Pleon with no anterolateral spines. Antennae positioned closely together; antenna 1 not small, article 1 distally with 1 rounded point, lateral flange absent; antenna 2 article 1 distolateral angle with horn-like prominent spine and terminal robust seta. Mandible lacinia mobilis reduced or absent; spine row either present or absent; palp absent, mandibular fossa angular, sub-horizontal across mandible. Pereopod 2 ambulatory, not enlarged, ischium

elongate; pereopods 5 and 6 carpus ranges from discoid to paddle-shape; dactyli of natatory pereopods narrowing distally. Pleopod 4 exopod with 1 to many plumose setae. Uropods biramous, exopod large and articulating.

Remarks. On studying Sars' material of *Echinozone coronata*, the type species for *Echinozone*, it can be found that *Notopais* differs from this genus in cephalon and body shape, the presence of pedestal setae and with the distinct shape of antenna 2 article 1. In *Notopais*, the frons is narrower compared with *Echinozone*, allowing the frontal arch to meet up with the maxillipeds at a wider angle, giving them a more horizontal appearance. The more acute angle between the frontal arch and maxillipeds seen in *Echinozone* gives it a much more triangular appearance, especially in lateral view. This structure adds more emphasis to the curvature of the animal and the body is more arched than in *Notopais*. *Notopais* has pedestal setae tipping all of its spines, similar to that found in *Bathybadistes* and these are not present in *Echinozone*. The shape of antenna 2 article 1 in *Notopais* is distinctive and not found in *Echinozone*. The shape is akin to a bull's horn and is always tipped with a robust seta making it more pronounced. The genus appears to be restricted to the Southern Hemisphere, from Antarctic waters to the south-east continental slope of Australia, at depths between 36–1640 metres.

Species included. *Notopais beddardi* Merrin, 2004b; *Notopais chathamensis* n. sp.; *Notopais echinatus* n. sp.; Notopais *euaxos* n. sp.; *Notopais likros* n. sp.; *Notopais magnifica* (Vanhöffen, 1914); *Notopais minya* Merrin, 2004b; *Notopais quadrispinosa* (Beddard, 1886); *Notopais spicata* Hodgson, 1910 (type species); *Notopais spinosa* (Hodgson, 1902); and *Notopais zealandica* Merrin, 2004b.

Key to the species of *Notopais*

1. — Anterior margin of pereonite 5 either smooth or with setae, spines absent ……..…..2
   — Anterior margin of pereonite 5 with spines ….....6

2. — Pereonite 5 anterior margin smooth, no setae present ….....3
   — Pereonite 5 anterior margin with either short stiff setae or with few long setae ……...4
3. — Cephalon with 4 spines, which are small enough to be regarded as tubercles; pereonites 2 and 3 anterior margin with 6 spines; pereonites 2–4 laterally with no spines; pereonite 5 anterior margin and dorsal surface smooth ….....*Notopais minya* Merrin, 2004b
   — Cephalon with 4 large, distinct spines, the inner pair larger than outer pair; pereonites 1–4 anterior margins with continuous row of spines; pereonites 2–4 laterally with many small spines (when mature adult); pereonite 5 dorsal surface with pair of rounded domes, one each side of centre, anterior margin smooth .....*Notopais magnifica* (Vanhöffen, 1914)

4. — Cephalon with spines; pereonites 1–4 anterior margins with spines ……..…….5
   — Cephalon with no dorsal spines; pereonites 1–5 anterior margins with robust setae only, large spines absent ...……*Notopais zealandica* Merrin, 2004b

5. — Cephalon with many small spines; in addition to marginal spines, pereonites 2–4 also with non-marginal spines; pereonites 5 anterior margin with few long simple setae …….……*Notopais likros* n. sp.
   — Cephalon with 2 dorsal spines only; pereonites 2–4 with marginal spines only; anterior margin of pereonite 5 with stiff simple setae ……..…….*Notopais beddardi* Merrin, 2004b

6. — Pereonites 6 and 7 with dorsal spines ……7
   — Pereonites 6 and 7 without dorsal spines …….…..9

7. — Pereonites 5–7 and pleon with many dorsal spines and tubercles …..8

— Pereonite 5 with marginal spines only, pereonites 6 and 7 each with pair of dorsal spines, pleon with no dorsal ornamentation ….....*Notopais spinosa* (Hodgson, 1902)

8. — Pereonites 1–4 with large spines; pereonite 5 anterior margin with evenly spaced spines; antenna 1 article 3 with no robust setae; uropodal protopodwith large distal extension ……..*Notopais echinatus* n. sp.
   — Pereonites 1–4 with small spines; pereonite 5 anterior margin with spines spaced widely apart; antenna 1 article 3 with robust setae; uropodal protopod with small bulbous distal extension .....…… .....*Notopais euaxos* n. sp.

9. — Pereonites 1–4 anterior margins each with more than two spines …..10
   — Pereonites 1–4 anterior margins each with pair of spines …….....*Notopais chathamensis* n. sp.

10. — Cephalon with pair of short dorsal spines; pereonite 4 with anterior facing spines set back from anterior margin; pereonites 1–4 length sub-equal to pereonites 5–7 …….*Notopais quadrispinosa* (Beddard, 1886)
    — Cephalon with pair of large, distinct dorsal spines; pereonite 4 with anterior facing spines on anterior margin; pereonites 1–4 length longer than pereonites 5–7 .....……*Notopais spicata* Hodgson, 1910

Notopais beddardi **Merrin, 2004 (Fig. 4.51)**

Notopais beddardi Merrin, 2004b: 10–13, fig. 3.

Material examined.— Holotype. Female (4.0 mm), Station 149H, off Cumberland Bay, Kerguelen Island, southern Indian Ocean, 48°45’S, 69°14’E, 29 January 1874, 232 m (recorded as 127 fathoms), volcanic mud, HMS *Challenger* (BMNH 2004.677).

Description. *Female.* Body 2.4 times as long as greatest width (from spine tip to spine tip) of pereonite 2; widest at pereonite 4; cuticle not highly

calcified, lightly setose. Cephalon lightly setose with 2 dorsal spines; posterior margins rounded, but almost square. Pereonites 1–4 anterior margins each with 4 well developed spines; pereonite 5 anterior margin with evenly spaced stiff SS; pereonites 1–4 anterolateral margins with spines, 5–7 rounded and smooth; pereonites 1–4 each with pair of lateral, sub-marginal spines. Pleon 0.6 times as long as proximal width, lateral sides rounded and posterior end coming to a rounded point, with scattered SS.

Antenna 1 article 1 1.7 times as long as wide, dorsal surface concave and forms shallow depression, distal margin with 5 RS; article 2 0.4 times as long as article 1, 2.4 times as long as wide, with 2 distal RS. Antenna 2 articles 1–3 more or less triangular; article 1 spine on distolateral angle with 3 additional RS on ventral side; article 2 1.2 times as long as article 1, distolateral angle with spine and 4 terminal RS, distomesial margin with 2 RS; article 3 1.3 times as long as article 1, distal rim with 5 long and 3 short RS, distomesial margin with 1 RS; article 4 small, 0.6 times as long as article 1, with no ornamentation.

Pereopod 2 basis 2.7 times as long as wide, inferior margin with 6 SS; ischium 2.1 times as long as wide, inferior margin with 7 SS (6 sub-marginal), lateral surface with 3 SS, superior margin with 2 SS (both in distal half); merus 1.7 times as long as wide, inferior margin with 4 SS, distosuperior margin with 4 SS; carpus 6.0 times as long as wide, inferior margin with 13 evenly spaced RS, superior margin with 4 SS (all in distal half); propodus 8.2 times as long as wide, inferior margin with 6 SS, superior margin with 3 SS (all in distal half); dactylus 9.7 times as long as proximal width.

Operculum 1.9 times as long as proximal width, medial keel with evenly spaced downward facing RS, lateral margins and distal surface with few setae (unable to determine actual types).

Males are not known for this species.

Remarks. *Notopais beddardi* can be identified by the combination of having only two dorsal spines on the cephalon; anterior facing marginal spines on only the first four pereonites, with robust setae on the corresponding margin of the fifth; the unique setal combinations of the first two articles in antenna 1 and the first three articles in antenna 2; the rounded anterior margin of pereonite

5; and the anterolateral margins of pereonites 5 and 6 rounded and smooth, and not coming to a point. The spines on the anterior margin of article 4 on *N. beddardi* are set on the absolute anterior margin, similar to that seen in *N. spicata* (although they are not as pronounced or as acutely angled) instead of almost being dorsal as is in *N. quadrispinosa*. *N. beddardi* does not have anterior spines on the fifth pereonite as in *N. quadrispinosa*, instead it has a row of short stout setae. The shape of pereonites 5–7 also differs between the two species. In *N. beddardi* these pereonites are broader than those in *N. quadrispinosa*. Pereonite 5 in *N. beddardi* has a rounded anterolateral margin, and the corresponding margins of pereonites 6 and 7 are not as acute as those in *N. quadrispinosa*. The spination of both antennae are also different between the two species. The first article of antenna 1 in *N. beddardi* has long robust setae around the distal margin, while *N. quadrispinosa* has robust setae along the lateral margin. The number of robust setae on the spines of the first two antennal articles of antenna 2 also differ, with *N. beddardi* having many more robust setae on the distolateral margins than in *N. quadrispinosa* which has a single robust seta terminating each spine. The position of robust setae on the distal margin of the article 3 of antenna 2 also differs between the two species, with those of *N. beddardi* being on the lateral margin, while on *N. quadrispinosa* they are on the mesial margin.

Distribution. Known only from type locality, off Kerguelen Island, southern Indian Ocean at a depth of 232 metres.

Etymology. For Frank E. Beddard, the distinguished biologist who described the many isopods that were collected during the *Challenger* expedition of 1873–1876.

***Notopais chathamensis* n. sp. (Figs 4.52–4.54)**

Material examined.— All material from South Island, New Zealand. Holoype. Female (4.0 mm), Chatham Rise, stn S147, 44°30.1'S, 174°18.8'E, Agassiz medium trawl with fine mesh inside, 25 October 1979, 760 m, RV *Tangaroa* (NIWA XXXX). Paratypes. 9 females, 4 males (1 female, dissected, 3.0 mm), type locality (NIWA XXXX). 4 males, 3 females (1 male dissected, 3.5 mm),

Chatham Rise, stn S148, 44°41.0'S, 174°20.9'E, Agassiz medium trawl with fine mesh inside, 25 September 1979, 859 m, RV *Tangaroa* (NIWA XXXX).

Additional material.— 1 male, Bounty Trough, stn E417, 45°12'S, 171°49'E, Hurley isopod trawl, 13 October 1965, 860 m, MV *Taranui* (NIWA XXXX). 1 female, Hikurangi Trough, stn F761, 42°33.2'S, 176°23.5'E, Agassiz medium trawl, 20 August 1966, 1234–1205 m, MV *Taranui* (NIWA XXXX). 2 females, 1 male, Chatham Rise, stn S131, 43°35.6'S, 175°57.8'E, Menzies trawl, 21 September 1979, 355 m RV *Tangaroa* (NIWA XXXX). 7 females, 7 fragments, Chatham Rise, stn F755, 43°00'S, 174°30'E, Menzies trawl, 19 August 1966, 721 m, MV *Taranui* (NIWA XXXX). 1 male, Chatham Rise, stn S132, 43°37.9'S, 175°58.0'E, Menzies trawl, 21 September 1979, 322 m RV *Tangaroa* (NIWA XXXX). 1 male, Chatham Rise, stn S130, 43°34.0'S, 175°57.7'E, Menzies trawl, 21 September 1979, 335 m RV *Tangaroa* (NIWA XXXX). 2 males, 1 female, Chatham Rise, stn F753, 44°45'S, 174°30'E, Menzies trawl, 18 August 1966, 854–788 m, MV *Taranui* (NIWA XXXX).

Description. Female. Body about 1.9 times as long as greatest width (from spine tip to spine tip) of pereonite 2; widest at pereonite 5; cuticle not highly calcified, smooth. Cephalon with pair of dorsal and pair of anterolateral spines. Pereonites 1–4 anterior margins each with pair of spines and pair of anterolateral spines; pereonite 5 anterior margin with 4 well-developed spines, anterolateral margin rounded, laterally with small indentation; pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with two small spines. Pleon 0.8 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point.

Antenna 1 damaged; article 1 1.1 times as long as wide, mesial margin with 1 SS, surface with 2 SS, lateral margin with 1 PNS and 5 SS, distal margin with 2 SS and 1 PNS; article 2 cylindrical, 0.4 times as long article 1, 0.3 times as long as wide, with 3 PNS and 3 SS (all at distal end); article 4 with 2 PNS. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 with 5 SS; article 2 0.9 times as long as article 1, distolateral margin with 1 SS; article 3 1.2

times as long as article 1, mesial margin with 1 SS, distally with 4 SS; article 4 1.1 times as long as article 1, with no ornamentation.

Mandible spine row and lacinia mobilis absent; molar small, terminated with 1 SS and 8 uni-serrate setae. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.1 times as wide as mesial lobe, distal margin with few fine SS, 5 RS, 3 dentate RS and 4 pectinate RS, mesial lobe distally with 5 SS, few fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.1 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 1.9 times as wide as lateral lobe, margins with fine SS, distally with 4 SS, 4 toothed setae and 1 long pectinate seta. Maxilliped coxa square, 1.0 times as long as wide, 0.3 times as long as basis (including endite); basis elongate, 2.6 times as long as wide (including endite), with 5 SS; endite with 3 coupling hooks, distally with 5 toothed setae, 5 fan setae (distomesial one longest) and few fine SS; palp article 1sub-rectangular, 0.3 times as long as basal endite, surface with 1 SS, distomesial margin with 1 SS; article 2 3.0 times as long as and 1.4 as wide as article 1, 1.7 times as wide as basal endite, lateral margin with 3 SS, surface with 1 SS, mesial margin with 3 distally pappose setae; article 3 1.6 times as long as and 0.8 times as wide as article 1, lateral margin with 1 SS, surface with 1 SS, mesial margin with 3 SS and 9 distally pappose setae; article 4 0.6 times as long as and 0.3 as wide as article 1, lateral margin with 1 SS, mesial margin with 3 distally pappose setae; article 5 narrow, 0.8 times as long as and 0.1 times as wide as article 1, with 5 terminal SS; epipod 1.4 times as long as wide, 1.0 times as long as basis, margins with cuticular scales and 5 SS (3 marginal).

Pereopod 1 basis 5.2 times as long as wide, inferior margin with 1 SS, lateral surface with 3 SRS (all at distal end), superior margin with 13 SS; ischium 3.3 times as long as wide, inferior margin with 5 SS, lateral surface with 2 SS, superior margin with 2 SRS and 2 SS; merus 0.8 times as long as wide, inferior margin with 10 SS, lateral surface with 2 SS, distosuperior margin with 2 SS; carpus 3.3 times as long as wide, inferior margin with 9 SS, superior margin with 4 SS; propodus 5.1 times as long as wide, inferior margin with 6 SS, lateral

surface with 3 SS, superior margin with 5 SS; dactylus 2.6 times as long as proximal width, distosuperior margin with 4 small SS.

Pereopod 5 basis 3.2 times as long as wide, inferior margin with 1 SS, lateral surface with 1 SS, superior margin with 1 SRS and 3 SS; ischium 2.2 times as long as wide, inferior margin with 2 SRS and 3 SS, lateral surface with 5 SS (all in superior half); merus 1.1 times as long as wide, inferior margin with 12 SS, lateral surface with 1 SS, distosuperior margin with 2 SS; carpus 0.9 times as long as wide, lateral surface with 3 small SS, distosuperior margin with 1 SRS; propodus 2.7 times as long as wide, distoinferior margin with 1 SS, lateral surface with 8 scattered SS, distosuperior margin with 1 SS and 1 PNS; dactylus 4.5 times as long as proximal width, superior margin with 9 SS.

Pereopod 7 basis 5.4 times as long as wide, inferior margin with 3 short plumose setae and 2 SS, superior margin with 2 short plumose setae and 1 SS; ischium 2.4 times as long as wide, inferior margin with 2 SS; merus 1.2 times as long as wide, inferior margin with 3 SS, distosuperior margin with 1 SS; carpus 1.8 times as long as wide, lateral surface with 1 SS; propodus 6.2 times as long as wide, also distoinferior margin with 2 SS, lateral surface with 3 SS, distosuperior margin with 1 PNS and 1 SS; dactylus 5.0 times as long as proximal width, superior margin with 5 SS.

Operculum 2.9 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with row of RS and SS, margins anterolaterally with 4 + 4 SS, laterally with numerous plumose setae. Pleopod 3 exopod, 1.5 times length of endopod, distally with 5 long plumose setae and 1 SS; endopod 1.4 times as long as wide, with 6 long plumose setae. Pleopod 4 exopod with 3 terminal long plumose setae; endopod oval, 1.4 times as long as wide. Pleopod 5 1.7 times as long as wide.

Uropod protopod 2.4 times as long as wide, distal end rounded, lateral margin with 7 plumose setae, distal margin with 6 SS, surface with 4 scattered SS; exopod 0.2 times as long as protopod, 1.0 times as long as endopod, with 1 SS; endopod 0.2 times as long as protopod, with 5 distal PNS and 1 SS.

Male. Antenna 1 of 25 articles; article 1 1.4 times as long as wide, surface with 1 SS, distal margin with 3 PNS and 1 SS; article 2 1.4 times as long as wide,

distal margin with 2 SRS and 1 PNS; article 3 with 1 SS; article 4 with 2 PNS; article 7 with 1 SS; from article 9 onwards, each article has 1 aesthetasc, many articles with additional SS; terminal article with 1 SS and 1 aesthetasc.

Pleopod 1 3.8 times as long as proximal width, lateral margins indent 0.4 from proximal end, either side of central margin with 9 setae (2 SRS and 2 SS + 5 SS), distally with 24 SS (14+10; are somewhat overlapped *in situ*, have been drawn separately). Pleopod 2 protopod 2.6 times as long as wide, lateral margin with 1 SS and row of plumose setae, surface with 11 SS, distally with lamellar extension, mesial margin with 7 plumose setae; exopod hooked, 0.1 times as long as protopod, with fine SS; stylet 0.6 times as long as protopod, not hooked up into proximal part of protopod, terminating to a point; sperm duct 0.7 times as long as stylet.

Remarks. *Notopais chathamensis* n. sp. is distinguished by the two spines on the anterior margins of pereonites 1–4, which is unique as in the other species with marginal spines all have at least four spines on each. *N. chathamensis* is somewhat similar to *Notopais quadrispinosa*, but it can be distinguished from this species by the unique spination pattern on pereonites 1–4 and the spines on pereonite 4 in *N. quadrispinosa* are not marginal, while these are in *N. chathamensis*.

Distribution. On and adjacent to the Chatham Rise, east of the South Island, New Zealand, from the Hikurangi Trough at latitude 42° South to the Bounty Trough, between 322–860 metres.

Etymology. Named for the type locality, the Chatham Rise, east of South Island of New Zealand.

Notopais echinatus n. sp. (Figs 4.55–4.57)

Material examined.— Holotype. Female (two halves together, 8.5 mm), continental slope of eastern Australia, east of Flinders Island, Tasman Sea, stn FR1086-4, 40°45.94'–46.54'S, 149°01.62'–0.27'E, 2400–2500 m, 10 December 1986, clay, thick mud, light grey colour, some rock (siltstone) (ex AM P62613). Paratypes. 3 females, (8 mm [two halves together], dissected; 6 mm, dissected) 2

male (7 mm [two halves together], dissected), 4 fragments, type locality (ex AM P62613).

Description. *Female*. Body about 2.5 times as long as greatest width (from spine tip to spine tip) of pereonite 2; pereonites 2 and 3 width sub-equal, widest; cuticle calcified, with many tubercles. Cephalon with 2 larger and 4 smaller spines; lateral margins with several small spines; posterolateral margins sub-rectangular. Pereonites 1–4 with numerous tubercles; anterior margins each with 4 well-developed sub-marginal spines, pereonites 1–4 laterally with pair of marginal spines, pereonite 4 with additional pair of lateral spines; pereonites 5–7 dorsally with many pairs of spines and tubercles; pereonite 5 anterior margin with 2 pairs of widely spaced spines, anterolateral margin twice indented; pereonite 6 with small anterolateral lobes, ventrally with 6 scattered setae; pereonite 7 anterolateral margins rounded., ventrally with row of setae. Pleonite 1 with 1 pair of spines. Pleon as long as proximal width, posterior tip rounded, dorsally with several pairs of tubercles.

Antenna 1 of 9 articles; article 1 elongate, distal ends rounded, 1.7 times as long as wide, mesial margin with 3 SRS (2 long, 1 short), surface with 2 PNS and 1 RS, lateral margin with 8 SRS, distal margin with 3 PNS and 1 SRS; article 2 0.3 times as long article 1, 1.8 times as long as wide, with 1 mesial SS, distally with 2 RS and 1 PNS; article 5 with 1 SS; from article 7, each article has an aesthetasc; terminal article also with 1 PNS and 1 SS.

Mandible lacinia mobilis and spine row absent; molar small, 5 uni-serrate setae. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.1 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 1 dentate RS, 2 dentate pectinate RS and 6 robust pectinate setae; mesial lobe distally with 8 SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.0 times as wide as lateral lobe, margins and surface with fine SS, distally with 6 SS, 7 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, 1.2 times as long as wide, 0.3 times as long as basis (including endite); basis elongate, 2.4 times as long as wide (including endite),

distolateral margin with 1 SS; endite with 5 coupling hooks, distally with 6 blunter SS, 8 fan setae (distomesial one longest) and many fine SS; palp article 1 wide, shortest, rectangular, 0.3 times as long as basal endite, distolateral margin with 1 SS on anterolateral margin, distomesial margin with 1 SS; article 2 3.9 times as long as and 1.2 as wide as article 1, 1.6 times as wide as basal endite, lateral margin with 7 SS and cuticular scales, mesial margin with 6 distally pappose setae (of varying lengths); article 3 1.9 times as long as and 0.8 times as wide as article 1, mesial margin with 1 long SS and 16 distally pappose setae (2 sub-marginal); article 4 rectangular, with distomesial bulge, 1.1 times as long and 0.4 as wide as article 1, lateral margin with 2 SS, distomesial margin with 4 SS and 4 distally pappose setae; article 5 small, rectangular, narrow, 0.9 times as long as and 0.1 times as wide as article 1, lateral margin with 1 SS, terminally with 5 SS; epipod 1.8 times as long as wide, and as long as basis, lateral margin with fine SS and few scattered SS.

Pereopod 1 basis 4.5 times as long as wide, inferior margin with 4 SS and 1 distal SRS, superior margin with 1 SS and 1 SRS; ischium 5.0 times as long as wide, inferior margin with 3 evenly spaced SS, lateral surface with 3 SS, superior margin with 2 SRS and 1 distal SS; merus 1.1 times as long as wide, inferior margin with 2 marginal SRS and 3 RS, lateral surface with 2 SRS, distosuperior margin with 3 SS; carpus 5.9 times as long as wide, inferior margin with 3 SS (in proximal half), superior margin with 3 evenly spaced SS; propodus 7.7 times as long as wide, inferior margin with 8 SS (all in distal half, 5 sub-marginal), lateral surface with 2 SS, superior margin with 3 distal SS; dactylus 2.6 times as long as proximal width, superior margin with 2 SS.

Pereopod 2 basis 4.2 times as long as wide, inferior margin with 3 SRS, superior margin with 3 SRS (1 on distal margin); ischium 4.6 times as long as wide, inferior margin with 13 SRS (of varying lengths, 2 sub-marginal), superior margin with 9 SRS and 1 proximal SS; merus 1.7 times as long as wide, inferior margin with 9 SRS, lateral surface with 2 SRS, distosuperior margin with 2 SRS (1 long and 1 short); carpus 7.9 times as long as wide, inferior margin with 9 SRS (lengths varying), superior margin with 6 SRS, 4 SS and 1 PNS (all evenly spaced except for 2 SRS, 1 SS and 1 PNS on distosuperior margin); propodus

10.2 times as long as wide, inferior margin with 9 SRS and 1 distal SS, lateral surface with 4 SS, superior margin with 4 evenly spaced SS and 2 small sub-marginal SS, distally with 1 long SS, 1 PNS and a clump of 4 SS; dactylus 6.9 times as long as proximal width, superior margin with 9 small SS and lateral surface with 5 SS.

Pereopod 6 basis 4.1 times as long as wide, inferior margin with 1 proximal SS, 5 plumose setae and 2 distal SRS, superior margin with 1 SS (at mid-point); ischium 2.2 times as long as wide, inferior margin with 7 long SRS and 5 SS (4 SS are sub-marginal); merus 1.1 times as long as wide, inferior margin with 4 long SRS and 3 sub-marginal SS; carpus 1.2 times as long as wide; propodus 4.2 times as long as wide, inferior margin with 2 distal SS, superior margin with 1 distal SS; dactylus 5.8 times as long as proximal width, with 7 SS.

Operculum 2.1 times as long as proximal width, median keel provided with row of RS and few RS proximally, surface with scattered SS, distally with 11 plumose setae (6 of these in a row, 3 each side of medial split), medial excision and veined lamellar extension, lateral margins with numerous plumose setae. Pleopod 3 exopod 1.2 times length of endopod, with row of fine SS, distally with 10 long plumose setae; endopod 1.7 times as long as wide, with 10 long plumose setae. Pleopod 4 exopod apex with 5 long plumose setae; endopod oval, 1.4 times as long as wide. Pleopod 5 1.6 times as long as wide.

Uropod protopod 2.5 times as long as wide, lateral margin with 4 SS and 14 plumose setae, surface with 9 scattered SS, distomesial angle produced, not extending past endopod, provided with 4 SS and 2 plumose setae; exopod small, 0.1 times as long as protopod, 0.5 times as long as endopod, with 5 SS; endopod 0.2 times as long as protopod, with 5 SS and 7 PNS.

Male. Antenna 1 with 8 articles; article 1 and 2 ratios similar to female; article 1 mesial margin with 5 SRS, distal margin with 3 SRS and 2 PNS, lateral margin with 2 SRS and 1 PNS; article 2 2.3 times as long as wide, distal margin with 2 SRS and 3 PNS; article 6 with 1 aesthetasc. Antenna 2 damaged; article 1 lateral margin with 2 SRS; article 2 1.1 times as long as article 1, distolateral margin with 1 SRS; article 3 1.9 times as long as article 1, scale with 2 SRS,

distomesial margin with 5 SRS; article 4 small, 1.3 times as long as article 1, with no ornamentation.

Pleopod 1 about 3.3 times as long as proximal width, lateral margins indented 0.5 from proximal end, with 24 SS (13+11) on either side of centre margin, distally with 20 SS (8+12). Pleopod 2 protopod 3.1 times as long as wide, lateral margin with row of plumose setae, surface with 29 SS, distal margin with 4 plumose setae (all sub-marginal), mesial margin with 4 plumose setae; exopod 0.1 times as long as protopod, with fines SS; stylet 0.5 times as long as protopod, terminating to a point, not hooking up into proximal part of protopod; sperm duct 0.6 times as long as stylet.

Remarks. Notopais echinatus n. sp. is most similar to *Notopais euaxos*, both species differing from all others in the genus in being highly ornamented, with numerous dorsal pereonal spines and tubercles. In dorsal view, *N. echinatus* differs from *N. euaxos* by having larger spines on the anterior margins of pereonites 1–4; fewer tubercles on the posterior margin of pereonites 1–4; pereonite 5 anterior margin with 4 evenly spaced spines as opposed to a pair of spines widely spaced; more larger spines on pereonites 5–7; and a different patterning of spines and tubercles on the pleon. Other differences between the two species include: *N. echinatus* antenna 2 article 1 with fewer RS and article 3 distolateral margin only having 2 robust flagellate setae, while in the corresponding position for *N. euaxos* is a small rounded distolateral angle with 5 RS; pereopod 1 of *N. echinatus* has fewer setae than its counterpart, especially on the inferior margins of the merus and carpus; and the operculum of *N. echinatus* has numerous plumose setae and SS between the end of the keel and the distal margin, while in *N. euaxos* there are no setae in this area, with just a few long plumose setae at the distal end of the medial keel.

The unguis which has been illustrated for the respective pereopods of both *N. echinatus* and *N. euaxos* differ to those illustrated for *Notopais minya* and *Notopais zealandica* (see Merrin 2004). All pereopodal ungui in both *N. minya* and *N. zealandica* have been illustrated with 2 sensillae and these sensillae are pointed. Closer examination has shown that the sensillae are blunter than originally thought and that the unguis has 2 sensillae in pereopods 1 and 2

(pereopods 3 and 4 remain unknown for the genus) and only one sensilla for pereopods 5–7 (pers. l obs.). Re-examination of the type material for *N. minya* and *N. zealandica* shows the structure of the unguis to be the same as that described here.

Distribution. Known only from the type locality, east of Flinders Island, Tasman Sea, Australia, between the depths of 2400–2500 metres.

Etymology. From the Latin *echinatus* (=spiny or prickly); in reference to the dorsal spines and tubercles.

***Notopais euaxos* n. sp. (Figs 4.58–4.59)**

Material examined.— Holotype. Female (9.0 mm), Chatham Rise, South Island, New Zealand, stn S202, 42°14.7'S, 175°8.6'E to 42°16.6'S, 175°10.6'E, epibenthic sled, 2476–2542 m, RV *Tangaroa* (NIWA XXXX). Paratype. Female (12.5 mm), type locality (NIWA XXXX).

Description. Body about 2.7 times as long as greatest width (from spine tip to spine tip) of pereonite 2; pereonites 2 and 3 width subequal, widest; cuticle calcified, with many tubercles. Cephalon with 2 larger and 2 smaller spines and numerous tubercles; lateral margins with several small spines; posterolateral margins rounded, but almost square. Pereonite 1 anterior margin with 2 widely-spaced sub-marginal spines, pereonites 2–4 with 4 sub-marginal spines; numerous tubercles between these spines; posterior margins with row many tubercles; pereonites 1–3 anterolateral margins smooth, pereonite 4 anterolateral margins with small spines; pereonite 2 with 3 pairs of small lateral spines, pereonite 3 with 2 pairs, pereonite 4 with 1 pair of spines; pereonites 5–7 dorsally with at least 1 pair of spines and numerous tubercles; pereonite 5 anterior margin with 2 pairs of widely-spaced spines, anterolateral margin square; pereonite 6 anterolateral margin with small lobes; pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with row of setae. Pleonite 1 with 1 pair of spines. Pleon as long as proximal width, lateral sides indent and posterior end coming to a rounded point, dorsally with several pairs of tubercles.

Antenna 1 damaged; article 1 elongate, distal end rounded, 1.8 times as long as wide, mesial margin with 5 SRS, surface with 5 PNS, lateral margin with 8 SRS, distal margin with 1 long PNS; article 2 0.5 times as long as article 1 and 2.3 times as long as wide, lateral margin with 1 SRS, distomesial cornier with 3 PNS, mesial margin with 1 PNS and 1 SS; article 3 elongate, 0.9 times as long as article 1 mesial margin with 2 SRS. Antenna 2 damaged; article 1 lateral margin with 3 RS, mesial margin with 1 RS; article 2 0.6 times as long as article 1, distolateral margin with 2 SRS; article 3 as long as article 1, scale with 5 RS (1 sub-marginal), mesial margin with 3 SRS, distomesial margin with 7 SRS (5 in a clump, 2 separate); article 4 small, 0.9 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis and spine row absent; molar small, distally with 11 uni-serrate setae. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.7 times as wide as mesial lobe, distal margin with numerous fine SS, 8 RS, 2 dentate RS and 2 robust pectinate setae; mesial lobe distally with 1 SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 0.9 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 1.9 times as wide as lateral lobe, mesial and distal margins with fine SS, distally with 7 SS, 9 toothed setae and 1 long pectinate seta. Maxilliped coxa roughly triangular, 1.0 times as long as wide, 0.3 times as long as basis (including endite); basis elongate, 2.6 times as long as wide (including endite); endite with 7 coupling hooks, distally with 7 SS, 9 fan setae (distomesial one longest) and many fine SS; palp article 1 wide, shortest, 0.2 times as long as basal endite, rectangular, distolateral margin with 1 SS distomesial margin with 1 SS; article 2 5.0 times as long as and 1.3 as wide as article 1, and 1.6 times as wide as basal endite, lateral margin with 11 SS (1 sub-marginal), mesial margin with 3 distally pappose setae and 1 long SS; article 3 2.5 times as long as and 0.8 times as wide as article 1, mesial margin with 4 longer SS and 16 distally pappose setae; articles 4 and 5 rectangular; article 4 1.7 times as long as and 0.3 as wide as article 1, lateral margin with 3 SS, distomesial margin with 3 SS; article 5 narrow, setae missing, 1.3 times as long

as and 0.1 times as wide as article 1; epipod 1.8 times as long as wide, and as long as basis.

Pereopod 1 basis 7.2 times as long as wide, inferior margin with 7 SS, lateral surface with 1 SS, superior margin with 3 SS and 1 medial SRS; ischium 5.4 times as long as wide, inferior margin with 6 SS, lateral surface with 6 scattered SS, superior margin with 5 SS; merus 1.1 times as long as wide, inferior margin with 5 SS and 17 SRS, lateral surface with 1 SS, distosuperior margin with 2 SS; carpus 6.3 times as long as wide, inferior margin with 8 SS (lengths varying, all in proximal half), superior margin with 2 SS; propodus 9.9 times as long as wide, inferior margin with 12 SS, lateral surface with 4 SS, superior margin with 1 SS; dactylus 3.1 times as long as proximal width, superior margin with 4 SS.

Operculum 3.2 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with row of RS (possibly all SRS, given last one is), scattered SS and proximally with 3 plumose setae, surface with scattered SS, lateral margins with numerous plumose setae. Pleopod 3 exopod 1.1 times length of endopod with row of fine SS, distally with 12 long plumose setae; endopod 1.8 times as long as wide with 18 long plumose setae. Pleopod 4 exopod distally with 5 long plumose setae; endopod oval, 1.3 times as long as wide. Pleopod 5 1.9 times as long as wide.

Uropod protopod 3.4 times as long as wide, margins sub-parallel, lateral margin provided with 8 SS and 13 plumose setae, mesial margin with 1 SS and 5 plumose setae, surface with 9 scattered SS and 1 plumose seta, distomesial angle produced, not extending past endopod, provided with 1 plumose seta and 2 SS; exopod small, 0.1 times as long as protopod, 0.4 times as long as endopod, with 4 SS; endopod 0.2 times as long as protopod, with 3 SS and 5 PNS.

Males are not known for this species.

Remarks. See ‘Remarks’ for *N. echinatus*.

Distribution. Known only from type locality, Chatham Rise, South Island, New Zealand, between 2476–2542 metres.

Etymology. The Greek word euaxos (easily broken); alluding to the frequently broken pedestal setae.

***Notopais likros* n. sp. (Figs 4.60–4.63)**

?*Ilyarachna* sp. Monod, 1973: 287–291, figs 1–22.

Material examined.— All material from eastern Australia. Holotype Female (4.2 mm), Providential Head, NSW, stn 4-288, 34°08.00'S, 151°08.50'E, 3 January 1991, 65–70m (ex AM P62646). Paratypes. 1 female (3.8 mm), type locality (ex AM P62646). 1 male (2.0 mm), Cape Banks, NSW, stn T4-371, 34°00.00'S, 151°16.00'E, 3 January 1991, 65–70 m (AM P62639). 1 female (4.0 mm), Bass Point, NSW, stn BP4-247, 34°36.00'S, 150°54.00'E, 3 January 1991, 65–70 m (AM P62634).

Additional material.— 2 males and 4 females, east of Port Jackson, NSW, stn K80-20-11, 33°52'S, 151°23'E, 11 December 1980, 80 m (AM P32678). 6 females, 2 fragments, south-east of Broken Bay, NSW, stn K86-01-02, 33°36'–37'S, 151°30'–29'E 10 February 1986, 71-75 m, FRV *Kapala* (AM P38888). 13 females, 4 males and 6 fragments, east of Port Jackson, NSW, stn K80-20-11, 33°52'S, 151° 23'E, 11 December 1980, 80 m, FRV *Kapala* (AM P38890). 1 female, Bass Strait, stn SS05/94/59, 38°56.50'S, 148°19.30'E, 27 August 1994, 80–85 m, *Southern Surveyor* (AM P62621). 1 male, south-east of Bermagui, NSW, SS05/94/156, 36°23.30'S, 150°10.60'E, 5 September 1994, 76–79 m, *Southern Surveyor* (AM P62623). 1 female, south-east of Bermagui, NSW, SS05/94/155, 36°26.00'S, 150°14.10'E, 5 September 1994, 119–122m *Southern Surveyor* (AM P62624). 1 female and 1 male, Bass Point, NSW, stn BP43, 34°36.00'S, 150°54.00'E, 25 June 1990, 45-50 m (AM P62625). 1 female, Bass Point, NSW, stn BP55, 34°36.00'S, 150°54.00'E, 25 June 1990, 65–70 m (AM P62626). 1 female, Bass Point, NSW, stn BP56, 34°36.00'S, 150°54.00'E, 25 June 1990, 65–70 m (AM P62627). 1 female, Bass Point, NSW, stn BP3-29, 34°36.00'S, 150°54.00'E, 29 October 1990, 45–50 m (AM P62629)1 male, Bass Point, NSW, stn BP3-36, 34°36.00'S, 150°54.00'E, 29 October 1990, 45–50 m (AM P62630). 1 male, Bass Point, NSW, stn BP3-46, 34°36.00'S, 150°54.00'E, 29 October 1990, 65–70 m (AM P62632). 1 female, Bass Point, NSW, stn BP4-226, 34°36.00'S, 150°54.00'E, 3 January 1991, 45–50 m (AM P62633). 2 males, south-east of Bate Bay, NSW, stn C80, 34°05.90'S, 151°12.00'E, 25 June 1990,

65–70 m (AM P62635). 2 males, south-east of Bate Bay, NSW, stn C84, 34°06.80'S, 151°11.00'E, 25 June 1990, 65–70 m (AM P62636). 1 male, south-east of Bate Bay, NSW, stn T4-339, 34°05.90'S, 151°12.00'E, 3 January 1991, 65–70 m (AM P62637). 1 male, Cape Banks, NSW, stn T4-366, 34°00.00'S, 151°16.00'E, 3 January 1991, 65–70 m (AM P62638). 1 male, Cape Banks, NSW, stn T4-373, 34°00.00'S, 151°16.00'E, 3 January 1991, 65–70 m (AM P62640). 1 male, Providential Head, NSW, stn Mar-73, 34°08.00'S, 151°08.50'E, 29 October 1990, 45–50 m (AM P62641). 1 female, Providential Head, NSW, stn Mar-86, 34°08.00'S, 151°08.50'E, 29 October 1990, 65–70 m (AM P62642).1 female, Providential Head, NSW, stn Mar-88, 34°08.00'S, 151°08.50'E, 29 October 1990, 65–70 m (AM P62643). 1 male, Providential Head, NSW, stn Mar-94, 34°08.00'S, 151°08.50'E, 29 October 1990, 65–70 m (AM P62644). 1 male, Providential Head, NSW, stn Mar-95, 34°08.00'S, 151°08.50'E, 29 October 1990, 65–70 m (AM P62645). 1 male, 3 females, Providential Head, NSW, stn 4-291, 34°08.00'S, 151°08.50'E, 3 January 1991, 65–70m (AM P62647). 2 males, Providential Head, NSW, stn W63, 34°08.00'S, 151°08.50'E, 25 June 1990, 65–70m (AM P62649). 1 male, Providential Head, NSW, stn W65, 34°08.00'S, 151°08.50'E, 25 June 1990, 65–70m (AM P62650). 1 female, Providential Head, NSW, stn W66, 34°08.00'S, 151°08.50'E, 25 June 1990, 65–70 m (AM P62651). 1 male, east of Long Reef, NSW, stn K85-21-08, 33°43'–44'S, 151°46'E, 20 December 1985, 174 m FRV *Kapala* (AM P62655).

Description. Female. Body about 2.6 times as long as greatest width (from spine tip to spine tip) of pereonite 2; widest at pereonite 3; cuticle not highly calcified, setose. Cephalon with 6 pairs of dorsal spines; laterally with 3 pair of spines; posterolateral margins square. Pereonites 1 and 2 with 6 marginal spines and pair of lateral spines; pereonite 2 with additional pair of sub-lateral spines; pereonites 3 and 4 anterior margins with 8 and 10 spines respectively; pereonite 3 also with 2 pairs of lateral and 1 pair of sub-lateral spines; pereonites 5 and 6 with very long setae; pereonite 5 anterolateral margin square, pereonites 6 and 7 with small lobes; pereonite 6 ventrally with no ornamentation, pereonite

7 ventrally with medial ridge with many setae. Pleon 0.9 times as long as proximal width, posterior tip rounded, with scattered SS.

Antenna 1 of 13 articles; article 1 elongate, 1.1 times as long as wide, mesial margin with 3 SS, surface with 3 PNS in clump, 1 additional PNS and 2 SS, lateral margin with 3 SS and 4 SRS, distal margin with 3 SRS and 2 PNS; article 2, 0.4 times as long as article 1 and 1.5 times as long as wide, distally with 4 SRS and 3 PNS; article 3 with 1 SS; article 4 with 2 PNS; article 5 with 1 SS; from article 6, each article has 1 aesthetasc, many articles with an additional SS; terminal article with 1 SS and 1 PNS. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 lateral margin with 2 SRS and 2 SS; article 2 0.7 times as long as article 1, with 2 SS, one on vertical each margin; article 3 0.9 times as long as article 1, mesial margin with 1 SS, scale with 2 SRS and 1 SS; distomesial margin with 4 SRS; article 4 small, 0.6 times as long as article 1, with no ornamentation; article 5 4.4 times as long as article 1, mesial margin with 11 SRS (3 are sub-marginal), surface with 1 long SRS, lateral margin with 11 SRS, distal margin with 7 SRS (6 in a clump); article 6 8.6 times as long as article 1, mesial margin with 1 PNS towards distal end, 21 SRS (4 are in distal clump), lateral margin with 1 PNS towards distal end, 20 SRS (5 in clump at distal end); flagellum of 41 articles (at least), proximally many articles with SRS, more distally articles with SS.

Mandible spine row and lacinia mobilis absent; without cuticular scales; molar small, terminated with 4 SS (on left, 3 on right) and 3 uni-serrate setae. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.2 times as wide as mesial lobe, distal margin with 3 RS, 1 dentate RS, 2 pectinate dentate RS and 6 pectinate RS, mesial lobe terminated with 8 SS, and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.0 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.3 times as wide as lateral lobe, margins and surface with fine SS, distally with 7 blunt SS, 3 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, 1.4 times as long as wide, 0.3 times as long as basis (including endite), with 2 SS; basis elongate, 3.0 times as long as wide (including endite); endite with 4 coupling hooks, 10 toothed setae, 7 fan setae (distomesial one

longest) and many fine SS; palp article 1 rectangular, 0.2 times as long as basal endite, distolateral margin with 1 SS; article 2 6.5 times as long as and 1.5 as wide as article 1, 0.9 times as wide as basal endite, lateral margin with 8 SS, surface with 1 distally pappose, mesial margin with 4 distally pappose setae; article 3 3.3 times as long as and 1.1 times as wide as article 1, lateral margin with 2 SS, mesial margin with 4 SS and 19 distally pappose setae; article 4 1.5 times as long as and 0.4 times as wide as article 1, lateral margin with 2 SS, distal margin with 7 SS; article 5 narrow, 1.9 times as long as and 0.1 times as wide as article 1, with 4 terminal SS; epipod 1.6 times as long as wide, 1.1 times as long as basis, margins with cuticular scales and 3 SS.

Pereopod 1 basis 6.3 times as long as wide, distoinferior margin with 1 SS, lateral surface with 10 long SS, superior margin with 12 evenly spaced SS; ischium 5.5 times as long as wide, inferior margin with 5 long SS, lateral surface with 4 SS (5 SS on opposable surface), superior margin with 4 long SS; merus 1.4 times as long as wide, inferior margin with 11 SS, distosuperior margin with 3 SS; carpus 4.6 times as long as wide, inferior margin with 5 SS, (in proximal half), superior margin with 4 SS (1 at mid-point, 3 on distosuperior margin); propodus 7.3 times as long as wide, inferior margin with 10 SS, lateral surface with 1 SS, superior margin with 5 SS; dactylus 2.7 times as long as proximal width, superior margin with 1 SS.

Pereopod 2 basis 3.4 times as long as wide, inferior margin with 12 long SS, lateral surface with 7 SS, superior margin with 2 SS and 3 SRS; ischium 3.6 times as long as wide, inferior margin with 24 SRS and 1 SS, lateral surface with 10 SS, superior margin with 12 SRS and 5 SS; merus 1.8 times as long as wide, inferior margin with 11 SRS, lateral surface with 4 SS and 2 SRS, superior margin with 4 SRS and 1 SS; carpus 6.9 times as long as wide, inferior margin with 15 SRS, lateral surface with 5 SRS and 2 SS, superior margin with 1 PNS, 2 SS and 15 SRS; propodus 11.6 times as long as wide, inferior margin with 9 SRS, distoinferior corner with clump of 3 SS, lateral surface with 8 SS, superior margin with 11 SS, 1 PNS and 1 SRS; dactylus 10.6 times as long as proximal width, with 23 SS.

Pereopod 5 basis 4.3 times as long as wide, inferior margin with 13 SRS and 6 PNS, lateral surface with 29 scattered SS, 2 thicker SS at distal end and 3 SRS proximally on inferior half; ischium 2.6 times as long as wide, inferior margin with 14 SS, lateral surface with 16 scattered SS; merus 1.0 times as long as wide, inferior margin with 15 SS (marginal and sub-marginal), distosuperior margin with 1 SS; carpus 1.3 times as long as wide, lateral surface with 8 small scattered SS, distosuperior margin with 1 SRS; propodus 4.4 times as long as wide, distoinferior margin with 1 SS, lateral surface with 8 small scattered SS, distosuperior margin with 2 short SS, 1 PNS and 1 long SS; dactylus 8.8 times as long as proximal width, superior margin with14 fine SS, inferior margin with 6 sub-marginal fine SS.

Pereopod 6 basis 4.5 times as long as wide, inferior margin with 5 SS and 12 SRS (of varying sizes), lateral surface with 6 plumose setae, superior margin with 3 SS; ischium 2.6 times as long as wide, inferior margin with 19 SS, superior margin with 7 scattered SS; merus 1.0 times as long as wide, inferior margin with 17 SS, distosuperior margin with 1 SS; carpus 1.2 times as long as wide, lateral surface with 10 scattered SS, distosuperior margin with 1 SRS; propodus 4.6 times as long as wide, inferior margin with 2 SS, superior margin with 2 SS, 1 PNS and 3 small sub-marginal SS; dactylus 6.5 times as long as proximal width, with 22 scattered fine SS.

Pereopod 7 basis 4.7 times as long as wide, inferior margin with 7 SRS, 7 SS (1 sub-marginal) and 6 plumose setae, superior margin with 3 SS; ischium 2.9 times as long as wide, inferior margin with 15 long SS, superior margin with 4 long sub-marginal SS; merus 1.0 times as long as wide, inferior margin with 14 SS, distosuperior margin with 2 SS; carpus 2.7 times as long as wide, lateral surface with 20 SS, distosuperior margin with 1 SRS; propodus 7.9 times as long as wide, distoinferior margin with 1 SS, lateral surface with 7 SS (all in superior half), distosuperior margin with 1 PNS, 1 short and 1 long SS; dactylus 6.3 times as long as proximal width, with 33 fine SS.

Operculum 1.7 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with row of RS and SS, surface with scattered SS, margins anterolaterally with some SS, laterally

with numerous plumose setae. Pleopod 3 exopod, 1.0 times length of endopod, distally with 5 long plumose setae and 1 SS; endopod 2.0 times as long as wide, with 6 long plumose setae. Pleopod 4 exopod with 4 terminal long plumose setae; endopod oval, 1.8 times as long as wide. Pleopod 5 1.9 times as long as wide.

Uropod protopod 2.2 times as long as wide, distal end rounded lateral margin with 11 SS and 19 long plumose setae, distal margin with 3 long RS and 4 long plumose setae, surface with 20 scattered SS; exopod small, 0.1 times as long as protopod, 0.4 times as long as endopod, with 4 SS; endopod 0.3 times as long as protopod, with 5 PNS and 5 SS.

Male. Antenna 1 of 18 articles; articles 1 and 2 ratios similar to female; article 1 distal margin with 2 SRS, surface with 2 PNS, mesial margin with 4 SRS, 2 PNS and 1 SS; distal margin with 3 PNS and 2 SRS; article 4 with 2 PNS; article 6 with 1 aesthetasc; from article 8 onwards, each article has 1 aesthetasc and many with additional SS.

Pleopod 1 5.9 times as long as proximal width, lateral margins indent 0.5 from proximal end, ventral surface with 15 SS and 3 proximal RS + 12 SS and 2 proximal RS, distally with 19 SS (10 + 9). Pleopod 2 protopod 2.5 times as long as wide, lateral margin with 3 SS (in proximal half) and row of plumose setae, surface with 5 SS, distally with 5 plumose setae and lamellar extension, mesial margin with 3 plumose setae; exopod elongate, 0.1 times as long as protopod, with fine SS; stylet 0.7 times as long as protopod, not hooking up into proximal part of protopod; sperm duct 0.5 times as long as stylet.

Remarks. Notopais likros n. sp. is distinguished by the combination of: numerous dorsal spines on the cephalon and anterior margins of pereonites 1–4; pereonites 5 and 6 with elongate setae; and two robust setae on the coxae of pereopods 1 and 2. *N. likros* resembles *Notopais magnifica* as this species also has numerous spines on pereonites 1–4, but *N. likros* can be easily distinguished from *N. magnifica* as it does not have two large dorsal spines on the cephalon, but rather many small spines. *N. likros* also has several sub-marginal spines on pereonite 4 which are absent in *N. magnifica.*

Distribution. South-eastern Australian continental slope from East of Port Jackson, New South Wales, to Bass Strait, between 45–174 metres. If Monod's *Ilyarachna* sp. species is *N. likros*, then this species distribution continues north to off the south Queensland coast at 27°00'S, 153°36'E.

Etymology. Likros is a Greek word meaning antler, alluding here to the spines with apical setae on antenna 2 article 1, which together are reminiscent of a stag's antlers.

***Notopais minya* Merrin, 2004 (Figs 4.64–4.68)**

Notopais minya Merrin, 2004b: 13–21, figs 4–7.

Material examined.— All material from eastern Australia. Holotype. Ovigerous female (5.0 mm), Stn SLOPE 56, 44 km E of Nowra, NSW, from 34°55.79'–56.06'S, 151°08.06–07.86'E , 22 October 1988, WHOI epibenthic sled, muddy coarse shell, 429–466 m, RV *Franklin* (NMV J52877). Paratypes. 69 males, 91 females, 9 fragments (between 2.0–5.5 mm; 1 male, 3 mm and 2 females, 4.0 mm and 4.5 mm, dissected; 2 males, 3.5 mm and 2 mm, 1 female, 5 mm, dissected, for SEM), type locality (NMV J52876).

Additional material.— 2 males, 2 females, 2 fragments, 79-K-1 Stn 32, shelf, eastern Bass Strait, 39°41.7'S, 148°39.5'E, 27 March 1979, muddy sand, 115 m, HMAS *Kimbla* (NMV J18851). 4 males, 5 females, 1 fragment, Stn SLOPE 2, off Nowra, NSW, 34°57.9'S, 151°8.0'E, 14 July 1986, in bryozoa and shell, 503 m (bottom), RV *Franklin* (NMV J18847). 2 females, Stn SLOPE 19, off Eden, NSW, 37°07.3'S, 150°20.2'E, 20 July 1986, grey coarse shell, 520 m (bottom), RV *Franklin* (NMV J18848). 1 female, Stn S05/84/64, 15 km E of Cape Connella, Tas., 43°24.6'S, 147°32.5'E, 22 October 1984, 82 m, RV *Soela* (NMV J18874). 1 female, 79-K-1 Stn 33, Flinders Canyon, eastern Bass Straight, 39°40.3'S, 148°46.5'E, 27 March 1979, coarse shell, 293–329 m, HMAS *Kimbla* (NMV J18852). 2 males, 4 females, 3 fragments, Stn SLOPE 1, off Nowra, NSW, 34°59.52'S, 151°5.94'E, 14 July 1986, coarse shell, 204 m (bottom), RV *Franklin* (NMV J18846). 1 female, Stn SO5/84/29, Tasman Sea, eastern slope, 70 km S of Gabo Island, Vic., 38°10.3'S, 149°57.2'E, 14 October 1984, 592 m,

RV *Soela* (NMV J18854). 1 female, Stn SO5/84/30, Tasman Sea, eastern slope, 50 km S of Mallacoota, Vic., 38°06.2'S, 149°45.5'E, 14 October, 1984, 188 m, RV *Soela* (NMV J18855). 2 males, 7 females, 6 fragments, Stn SLOPE 40, south of Point Hicks, Vic., 38°17.7'S, 149°11.3'E, 24 July 1986, coarse sand, gravel and mud, 400 m (bottom), RV *Franklin* (NMV J18849). 3 males, 4 females, 79-K-1 Stn 35, shelf, eastern Bass Straight, 39°28.4'S, 148°41.8'E, 28 March, 1979, shell and sand, 110 m, HMAS *Kimbla* (NMV J18853).

Description. *Female.* Body 2.5 times as long as greatest width (from spine tip to spine tip) of pereonite 2; widest at pereonite 3; cuticle not highly calcified, lightly setose. Cephalon lightly setose with 4 spines; anterior margins with few small, SS; posterolateral margins broadly rounded. Pereonite 1 anterior margin with 4 well developed spines, pereonites 2 and 3 with 6 and pereonite 4 with 5; pereonite 5 anterior margin rounded; anterolateral margins of pereonites 6 and 7 with small lobes, facing anteriorly. Pleon 0.9 times as long as proximal width, posterior tip rounded, with scattered SS.

Antenna 1 of 13 articles; article 1 distal end rounded, concave in centre, 1.1 times as long as wide, mesial margin with 1 SS and 1 SRS, surface with 2 SS, 1 PNS and 4 SRS, lateral margin with 5 SS and 1 RS (broken); article 2 elongate, 0.5 times as long as article 1, 1.9 times as long as wide, with 2 SRS and 4 PNS; article 4 with 2 PNS; article 5 with 1 SS; from article 6 onwards, each article has 1 aesthetasc, many articles with additional SS; terminal article with 1 small SS and 1 PNS. Antenna 2 articles 1–3 more or less triangular; article 1 lateral margin with 3 SRS; article 2 0.6 times as long as article 1, with 3 SS; article 3 0.6 times as long as article 1, distal rim with 1 SS and 9 SRS (3 broken); article 4 small, 0.8 times as long as article 1, with no ornamentation; article 5 4.6 times as long as article 1, mesial margin with 1 proximal SS, 6 evenly spaced RS and 2 long RS (at midpoint), surface with 4 RS, 3 SRS and 1 PNS (at distal end), lateral margin with 7 RS and 2 SRS, distal margin with 8 blunt RS; article 6 10.3 times as long as article 1, mesial margin with 14 RS, 2 SRS, 2 distal PNS and 4 long RS, surface with 9 RS, 2 SRS and 2 long RS, lateral margin with 9 RS, 2

SRS, 2 distal PNS, distal margin with 4 SRS and 3 RS; flagellum of 33 articles (present, flagellum not complete), each setose.

Mandible without cuticular scales; spine row and lacinia mobilis absent; molar small, distally with 3 uni-serrate setae and 2 SS. Maxilla 1 lateral lobe 1.9 times as wide as mesial lobe, lateral and mesial margins with fine SS, distal margin with numerous SS, 5 RS, 3 dentate RS and 4 semi-plumose RS; mesial lobe margins with fine SS, distally with 15 SS and 2 long pectinate setae. Maxilla 2 lateral lobe with scattered fine SS, distally with 1 small and 4 long SS; middle lobe 1.1 times as wide as lateral lobe, distally with 4 long SS and 1 small SS; mesial lobe 3.4 times as wide as lateral lobe, margins with fine SS, distally with 14 SS, 5 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, small, 0.9 times as long as wide, 0.3 times as long as basis (including endite); basis elongate, length including endite 2.6 times as wide, with 5 proximal SS; endite with 5 coupling hooks, distally with 3 SS, 3 toothed setae, 6 fan setae (5 small, 1 large) and many fine SS; palp article 1 wide, rectangular, shortest, 0.1 times as long as basal endite, distolateral margin with 1 SS, distomesial margin with 1 SS; article 2 5.1 times as long as and 1.6 times as wide as article 1, 1.6 times as wide as basal endite, lateral margin with 9 evenly spaced SS, mesial margin with 4 SS (distal end); article 3 2.7 times as long as and 0.9 times as wide as article 1, distolateral margin with 1 SS, mesial margin with 12 SS and 17 distally pappose setae; article 4 1.6 times as long as and 0.5 times as wide as article 1, lateral margin with 1 distal SS, mesial margin with 7 SS; article 5 cylindrical, narrowest of all articles, 1.3 times as long as and 0.2 times as wide as article 1, with 6 terminal SS; epipod elongate, 1.8 times as long as wide, 1.1 times as long as basis length, with cuticular scales on margin.

Pereopod 1 basis 6.5 times as long as wide, inferior margin with 9 SS, lateral surface with 3 distal SRS, superior margin with 8 SS; ischium 4.3 times as long as wide, inferior margin with 2 SS, lateral surface with 22 scattered SS; merus 0.8 times as long as wide, inferior margin with 19 scattered SS, of varying length, distosuperior margin with 5 SS; carpus 5.0 times as long as wide, inferior margin with 5 long SS (proximal half), superior margin with 4 SS (1 at midpoint, 3 at most distal corner); propodus 9.8 times as long as wide, inferior margin with

14 SS (in distal half), lateral surface with 3 SS (in distal half), distosuperior margin with 3 SS; dactylus 4.5 times as long as proximal width, distosuperior margin with 4 SS.

Pereopod 5 basis 3.4 times as long as wide, inferior margin with 16 SS (3 on distal corner) and 2 proximal, sub-marginal SRS, lateral surface with 12 scattered SS and 1 SRS at distal end, superior margin with 2 SS and 6 SRS (all in distal half); ischium 2.4 times as long as wide, inferior margin with 13 SS (6 marginal, 7 sub-marginal), lateral surface with 12 SS, superior margin with 6 SS (5 sub-marginal and 1 distal); merus 0.9 times as long as wide, inferior margin with 22 SS (of varying lengths); carpus 3.6 times as long as wide, lateral surface with 14 scattered SS, distosuperior margin with 1 SRS; propodus slightly expanded, 3.6 times as long as wide, inferior margin with 2 SS on distal margin and 2 sub-marginal SS, superior margin with 10 sub-marginal SS, 1 long SS and 1 PNS on distal corner; dactylus 6.3 times as long as proximal width, with 12 SS.

Pereopod 6 basis thicker compared with basis in pereopod 5, 3.4 times as long as wide, inferior margin with 25 SRS, 4 plumose setae and 1 distal SS, lateral surface with 1 SS, superior margin with 3 SS; ischium 2.2 times as long as wide, inferior margin with 17 SS (11 marginal, 6 sub-marginal), superior margin with 4 sub-marginal SS (all in distal half); merus length 0.8 times as long as wide, inferior margin with 19 SS (of varying lengths); carpus 1.2 times as long as wide, lateral surface with 18 scattered SS; propodus 4.4 times as long as wide, inferior margin with 3 SS, superior margin with 12 SS; dactylus 9.3 times as long as proximal width, with 13 SS.

Pereopod 7 basis 4.6 times as long as wide, inferior margin with 17 SRS, 1 proximal plumose setae and 3 distal SS, superior margin with 3 short SS and 2 plumose setae at proximal end; ischium 2.5 times as long as wide, inferior margin with 14 SS, superior margin with 9 sub-marginal SS; merus 1.1 times as long as wide, inferior margin with 18 SS (of varying lengths), distosuperior margin with 2 SS; carpus 2.8 times as long as wide, inferior margin with 11 sub-marginal SS, superior margin with 12 sub-marginal SS and 1 SRS at distal corner; propodus 8.6 times as long as wide, superior margin with 11 sub-

marginal, evenly spaced SS, distal corner with 1 long SS and 1 PNS; dactylus 8.5 times as long as proximal width, superior margin with 14 scattered SS.

Operculum 1.8 times as long as proximal width, median keel provided with a row RS and SS, surface with scattered SS of varying lengths, distally with 14 plumose setae (7+7), medial slit and veined lamellar extension, lateral margins with numerous plumose setae. Pleopod 3 exopod 1.0 times as long as endopod, with row of fine SS, distally with 6 long plumose setae; endopod 1.7 times as long as wide, endopod with 8 long plumose setae. Pleopod 4 exopod with 4 terminal long plumose setae; endopod oval, 1.4 times as long as wide. Pleopod 5 1.8 times as long as wide.

Uropod protopod elongate, 2.3 times as long as wide, margins sub-parallel, distal end rounded, lateral margin with 19 plumose setae (4 broken) and 20 SS, mesial margin with 5 plumose setae, surface with 17 scattered SS; exopod small, 0.1 times as long as protopod, 0.4 times as long as endopod, with 3 SS; endopod 0.3 times as long as protopod, with 4 SS and 4 PNS.

Male. Antenna 1 of 22 articles; article 1 and 2 ratios similar to female, article 1 lateral margin with 3 SRS (1 long, 2 short) and 1 PNS (in clump with SRS), distal margin with 3 SRS and 1 PNS; article 2 1.6 times as long as wide, distal margin with 3 SRS and 3 PNS; article 5 with 2 PNS; from article 8 onwards each article has 1 aesthetasc and many having additional SS.

Pleopod 1 2.9 times as long as proximal width, lateral margins indent 0.3 from proximal end, either side of centre margin with 17 SS (9+8), distally with 29 SS (14+15). Pleopod 2 protopod 2.5 times as long as wide, superior margin with 1 SS and 15 plumose setae, lateral surface with 16 scattered SS, distal margin with 2 plumose setae and fringe of fine SS; exopod elongate and oval, length 0.1 times as long as protopod; stylet 0.3 times as long as protopod, not hooking up into proximal region of protopod, terminating to a point; sperm duct 0.2 times as long as stylet.

Remarks. Notopais minya shows some resemblance to *Notopais magnifica* although there are not as many spines on the first four pereonites as has *N. magnifica*. *N. minya* also has only 4 small spines on its cephalon instead of the 2 large dorsal and 2 smaller ones seen on the anterolateral angles of *N.*

magnifica. *N. minya* also has a unique setation pattern on the first four articles of antenna 2. Unlike other *Notopais* for example, *Notopais spicata* , article 2 has no distolateral spine. Pereonites 5–7 are similar to that of *Notopais beddardi*, except the anterolateral margins on pereonite 6 are more acute.

Distribution. South-eastern Australia, from Nowra, New South Wales to Eastern Bass Strait, depths from 110–592 metres.

Etymology. Minya is an Aboriginal word meaning small; noun in apposition.

***Notopais quadrispinosa* (Beddard, 1886) (Fig. 4.69)**

Ilyarachna quadrispinosa Beddard, 1886: 76–78, pl. 12, figs 2–6.— Nordenstam, 1933: 266–273, fig.77.— Stephensen 1947: 8.— Wolff, 1962: 95.— Amar & Roman, 1974: 579.

Echinozone quadrispinosa.— Kussakin, 1967: 312.— Schultz, 1976: 4–5.— Kussakin & Vasina, 1982: 326, fig. 29.— Brandt, 1990: 216–218, fig. 1 (part).

Notopais quadrispinosa.— Merrin, 2004b: 8–10, fig. 2.

Material examined.— Lectotype. Ovigerous female (6.0 mm), off Cumberland Bay, Kerguelen Island, southern Indian Ocean, Station 149H, 48°45'S, 69°14'E, 29 January 1874, 232 m (recorded as 127 fathoms), HMS *Challenger*, volcanic mud, (BMNH 1889.4.27.73).

Additional material.— Paralectotype. Female (pereonites 5–7 and pleon only, 2.0 mm), type locality (BHNM 2004.676).

Description. *Female.* Body 2.4 times as long as greatest width (from spine tip to spine tip) of pereonite 2; widest at pereonite 3; cuticle not highly calcified, lightly setose. Cephalon with 2 dorsal spines; anterolateral margins each with 2 small spines and 1 small sub-marginal spine; posterolateral margins rounded. Pereonites 1–3 and 5 anterior margins each with 4 well developed spines; pereonite 4 still with 4 well developed spines, but set back from anterior margin; pereonites 1–4 each with pair of widely spaced, small, dorsal spines near

lateral margins pereonites 3 and 4 only with pair of lateral, sub-marginal spines; pereonites 5–7 anterolateral margins pointing towards cephalon; . Pleon 0.9 times as long as proximal width, lateral sides rounded and posterior end coming to a rounded point, with scattered SS.

Antenna 1 of 11 articles (at least, number refers to what could actually be seen); article 1 distal end triangular, 1.5 times as long as wide, dorsal surface forms shallow depression, distal margin has 2 RS, lateral margin with 3 SS (in proximal half) and 4 evenly spaced RS; article 2 0.3 times as long as article 1, 2.0 times as long as wide with 4 RS (at least, all evenly spaced around distal margin); article 3 with 2 SS (at least). Antenna 2 article 1 with 3 SS; article 2 1.1 times as long article 1, distolateral angle with 2 spines, one smaller than other, both with terminal RS, distomesial margin with 1 RS and 2 SS; article 3 0.9 times as long as article 1, distolateral angle with spine terminated with 1 RS, distomesial margin with 5 long and 2 short RS in a clump; article 4 small, 0.3 times as long article 1, with no ornamentation.

Pereopod 1 basis 6.3 times as long as wide, inferior margin with 5 SS; ischium length 4.7 times as long as wide, inferior margin with 1 SS, superior margin with 2 SS; merus 1.2 times as long as wide, inferior margin with 2 SS, distosuperior margin with 2 SS; carpus 4.1 times as long as wide, inferior margin with 1 proximal SS; propodus 7.5 times as long as wide, inferior margin with 5 SS; dactylus 2.3 times as long as proximal width.

Operculum 4.0 times as long as proximal width, medial keel with proximal facing RS, surface, lateral and distal margins with few scattered long setae (unable to determine actual type).

Remarks. *N. quadrispinosa* can be distinguished by the distinctive setation on the antennae, four spines on the anterior margin of pereonites 1–3 and 5 in conjunction with pereonite 4 where the spines are set back from the absolute margin. For further morphological discussion please read the previous remarks section for *N. spicata*.

Distribution. Antarctica, reliably known from the Crozet Islands, southern Indian Ocean, to the Leopold and Astrid Coast, Princess Elizabeth Land, Antarctica, between 168–245 metres.

***Notopais spicata* Hodgson, 1910 (Figs 4.70–4.73)**

Notopais spicatus Hodgson, 1910: 70–71, pl. 8, fig. 1.

Pseudarachna spicata.— Vanhöffen, 1914: 593, fig. 126.— Hale, 1937: 43–45, figs 18–19.— Kussakin, 1967: 313–314, fig. 54.

Ilyarachna spicata.— Wolff, 1962: 95.— Amar & Roman, 1974: 579–580, fig. 11.

Echinozone spicata.— Schultz, 1976: 8-10, figs 3–4.

Pseudarachna vanhoeffeni.— Schultz, 1976: 13.

Echinozone quadrispinosa.— Brandt, 1990: 216, fig. 1 (part).

Notopais spicata.— Merrin, 2004b: 5–8, fig. 1.

Material Examined.— Holotype. Female (3.0 mm), Winter Quarters, McMurdo Sound, Ross Sea, Antarctica, 77°49'S, 167°7.06E, 28 February 1902, 36.6 metres (recorded as inside 20-fathom line), SS *Discovery* (BMNH 1910.3.18.150).

Additional material.— Male (3.0 mm), Gauss Station, Davis Sea, Antarctica, 66°2'S, 89°38'E, 12 August 1902 or 19 December 1902, 385 m, *Gauss* (ZMHB 17739). 4 females (5.5 mm, dissected; 7.0 mm), McMurdo Sound, Ross Sea, Antarctica, SU 91, approximately 77°S, 167°E, collected between 1958–1961, depth unknown (NIWA XXXX).

Description. *Female Holotype*. Body 2.3 times as long as greatest width (from spine tip to spine tip) of pereonite 2; widest at pereonite 2; cuticle not highly calcified, lightly setose. Cephalon with 2 dorsal spines; posterolateral margins rounded. Pereonites 1–5 anterior margins each with 4 well-developed spines; anterolateral margins of pereonites 1–4 with spines, 5–7 rounded and smooth; pereonites 1–4 with pair of lateral, sub-marginal spines and each with pair of widely spaced, small, dorsal sub-lateral spines. Pleon lateral sides indent and posterior end coming to a rounded point, with scattered SS.

Antenna 1 damaged; article 1 2.1 times as long as wide, dorsal surface concave, with 1 sub-marginal SRS, distal margin with 1 SRS and 1 PNS, lateral margin with 1 SS and 1 PNS; article 2 0.4 times as long as article 1, 2.0 times as

long as wide, distal margin with 1 SRS; article 3 with 2 SS; article 4 with 1 SS; article 6 with 1 distal aesthetasc. Antenna 2 broken, articles 1–2 short, both wider than long; article 1 lateral margin with 2 SS; article 2 1.2 times as long as article 1, distolateral angle with spine and terminal RS, mesial margin with 1 SS; article 3 1.0 times as long as article 1, distolateral angle with spine terminated with RS, mesial margin with 2 SS, and distomesial margin with 1 short RS, 2 long SRS and 1 SS; article 4 small, 0.8 times as long as article 1, not ornamented.

Pereopod 1 basis 7.2 times as long as wide, inferior margin with 2 SS, 1 distal SRS and 1 distal RS, lateral surface with 3 SS; ischium 3.8 times as long as wide, inferior margin with 3 SS, lateral surface with 2 SS; merus 1.3 times as long as wide, inferior margin with 4 SS, distosuperior margin with 1 SS; carpus 3.8 times as long as wide, inferior margin with 2 long SS (both in proximal half), superior margin with 3 SS (1 distal); propodus 4.0 times as long as wide, inferior margin with 8 SS (on distal half), superior margin with 2 distal SS; dactylus 3.3 times as long as proximal width, superior margin with 5 distal SS.

Pereopod 7 basis 3.3 times as long as wide, inferior margin with 3 SS and 1 SRS, lateral surface with 1 SS, superior margin with 3 SS; ischium 3.5 times as long as wide, inferior margin with 3 SS (2 distal), lateral surface with 1 distal SS, superior margin with 2 SS and 1 plumose seta; merus 1.7 times as long as wide, inferior margin with 4 distal SS, distosuperior margin with 2 SS; carpus 3.4 times as long as wide, inferior margin with 3 plumose setae, 3 SS and 2 sub-marginal SS, superior margin with 2 SS, 2 sub-marginal SS and 1 distal SRS; propodus 8.3 times as long as wide, inferior margin with 3 SS, lateral surface with 1 proximal SS, superior margin distally with 3 SS and 1 plumose seta; dactylus 6.0 times as long as proximal width, superior margin with 5 SS, inferior margin with 1 SS.

Operculum 2.7 times as long as proximal width, medial keel with robust setae, lateral and distal margin with numerous long setae (unable to identify actual type of setae).

Description based on additional female material. Pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with two small spines.

Antenna 1 of 9 articles; article 1 elongate, 2.5 times as long as wide, mesial margin with 3 PNS and 6 SS, lateral margin with 2 SS, distal margin with

2 SRS, 2 PNS and 1 SS; article 2 sub-rectangular, 0.35 times as long article 1, 1.8 times as long as wide, with 3 PNS, 3 SRS (at least) and 1 SS (all distal); article 3 with 1 SS; article 4 with 2 PNS; article 5 with 1 SS; from article 6, each article has 1 aesthetasc, many articles with an additional SS; terminal article with 3 SS. Antenna 2 damaged, articles 1–3 more or less triangular; article 1 with 9 SS; article 2 0.7 times as long as article 1, with spine similar to article 1 (also with apical RS), distolateral margin with 3 SS, distomesial margin with 1 SRS and 7 SS; article 3 1.2 times as long as article 1, scale spine-like with 2 SRS and 4 SS, distomesial margin with 2 SS and 7 SRS; article 4 slightly elongate, 0.9 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis reduced; spine row with 5 spines (on left, 7 on right); molar small, distally with 5 uni-serrate setae and few spines (on left molar, none on right). Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.9 times as wide as mesial lobe, distal margin with few fine SS, distal margin with 3 RS, 2 dentate RS, 6 pectinate RS and 2 pectinate dentate RS, mesial lobe distally with many SS and 2 long pectinate setae. Maxilla 2 lateral lobe with margins with fine SS, distally with 4 long pectinate setae; middle lobe 0.9 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.6 times as wide as lateral lobe, margins and surface with fine SS, proximally, mesial margin also with 15 long, plumose setae, distally with 8 SS, 6 blunt SS, 5 toothed setae, and 1 long pectinate seta. Maxilliped coxa rectangular, 0.9 times as long as wide, 3.2 times as long as basis (including endite); basis elongate, 2.4 times as long as wide (including endite), with 3 SS; endite with 4 coupling hooks, distally with 1 SS, 4 toothed setae, 7 fan setae (distomesial one longest dorsal surface with 4 distally fanned setae) and few fine SS; palp article 1 wide, short, 0.3 times as long as basal endite, distolateral margin with 1 SS, distomesial margin with 1 SS; article 2 3.2 times as long as and 1.5 as wide as article 1, 0.9 times as wide as basal endite, lateral margin with cuticular scales and 4 SS, surface with 2 SS, mesial margin with 3 distally pappose setae; article 3 2.2 times as long as and 0.9 times as wide as article 1, lateral margin with 1 SS, surface with 3 SS, mesial margin with 2 SS and 17 distally pappose setae; article 4 1.5 times as long as and 0.4 as wide as article 1, lateral margin with 1 SS, distal

margin with 3 SS and 4 distally pappose setae; article 5 narrow, 1 times as long as and 0.2 times as wide as article 1, with 5 terminal SS; epipod 1.5 times as long as wide, 1.1 times as long as basis, with 6 SS, margins with cuticular scales.

Pereopod 1 basis 4.5 times as long as wide, inferior margin with 2 SRS and 14 SS, superior margin with 4 SRS and 12 SS; ischium 4.1 times as long as wide, inferior margin with 3 SS, lateral surface with 7 SS, superior margin with 8 SS and 1 SRS; merus 1.3 times as long as wide, inferior margin with 12 SS, distosuperior margin with 4 SS and 1 SRS; carpus 4.3 times as long as wide, inferior margin with 8 SS (all but 2 in proximal half), superior margin with 3 SS; propodus 5.8 times as long as wide, inferior margin with 13 SS (in distal half), superior margin with 6 SS (in distal half); dactylus 1.4 times as long as proximal width, superior margin with 4 short SS (all in distal clump).

Pereopod 5 basis 4.5 times as long as wide, inferior margin with 11 SS and 2 SRS, superior margin with 3 PNS, 4 SRS and 6 SS; ischium 2.7 times as long as wide, inferior margin with 5 SRS and 10 SS, superior margin with 2 SRS and 1 SS; merus 1.1 times as long as wide, inferior margin with 5 SRS and 5 SS, distosuperior margin with 2 SS; carpus 2.2 times as long as wide, inferior margin with 14 SRS (no plumose setae present), lateral surface with 3 SS, distosuperior margin with 1 SRS; propodus 5.0 times as long as wide, inferior margin with 12 SS (no plumose setae present), superior margin with 6 SS and in distal clump, 4 SS and 1 PNS; dactylus 4.4 times as long as proximal width, inferior margin with 4 sub-marginal SS in distal half and superior margin with 8 SS.

Pereopod 6 basis damaged, inferior margin with at least 4 SS, superior margin with at least 5 SRS and 6 SS; ischium 2.6 times as long as wide, inferior margin with 5 SRS, 3 SS and 6 sub-marginal SS, superior margin with 2 SS; merus 1.3 times as long as wide, inferior margin with 4 SRS and 5 SS, distosuperior margin with 2 SS; carpus 3.1 times as long as wide, inferior margin with 12 SRS (no plumose setae present), lateral surface with 3 SS and 1 SRS, superior margin with 2 SS and 1 SRS; propodus 8.5 times as long as wide, inferior margin with 12 SS (no plumose setae present), superior margin with 5 SS, distosuperior clump with 6 SS and 1 PNS; dactylus 6.0 times as long as proximal width, inferior margin with 6 SS, superior margin with 5 SS.

Operculum 3.1 times as long as proximal width, medial keel with row of RS and few SS surface distally with 7 plumose setae (3+4), numerous scattered SS, medial excision and veined lamellar extension, lateral surface with scattered SS, margins anterolaterally with 7 SS (4+3), laterally with numerous plumose setae. Pleopod 3 exopod 1.1 times as long as endopod, distally with 9 long plumose setae and 1 SS; endopod 1.8 times as long as wide, with 8 long plumose setae. Pleopod 4 exopod with 4 terminal long plumose setae; endopod oval, 1.4 times as long as wide. Pleopod 5 1.8 times as long as wide.

Uropod protopod 2.7 times as long as wide, distomesial angle produced, not extending past endopod, margins with cuticular scales, lateral margin provided with 15 plumose setae and 3 SS, distal margin with 10 SS and 1 plumose seta, surface with 3 SS and 1 plumose seta; exopod small, 0.1 times as long as protopod, 0.4 times as long as endopod, with 3 SS; endopod 0.2 times as long as protopod, with 7 PNS and 3 SS.

Male. Similar to female in setation and spines although spines are more pronounced. Larger than female. Cephalon posterolateral margin squarer than in female, reaching beyond anterolateral margin of pereonite 1. Ventrally, frons not as narrow as in female (female not illustrated in lateral view), mouthparts not complete, so unable to comment on their position. Pereonite 4 anterolateral margin and pereonite 5 posterolateral margin with pair of robust setae; pereonites 1–5 anterior margins higher than in female; pereonites 5–7 not as rounded as in female. Pleon 1.1 times as long as proximal width.

Remarks. *Notopais spicata* is distinguished by: the prominent spines on the anterior margins of the first 5 pereonites; a single spine on each of the first two articles of antenna 2 and the antennal scale also spine-like; and the absence of plumose setae on the inferior margins of the carpus and propodus of pereopods 5 and 6.

This species was previously considered to be a junior synonym of *N. quadrispinosa* by Hessler & Thistle (1975) and Brandt (1990). After redescribing the type material for both species, it is clear that they are distinct. The spines on the cephalon and anterior margins of the first five pereonites of *N. spicata* are more strongly produced and more acute than those of *N. quadrispinosa*. The

anterior spines on the fourth pereonite are set back from the anterior margin of *N. quadrispinosa* while in *N. spicata* these spines are on the absolute anterior margin. The shape of pereonites 5–7 differs markedly between the two species, in *N. spicata* the lateral margins are rounded and in *N. quadrispinosa*, the anterolateral margins are pointed towards the cephalon. The arrangement of spines and robust setae on both antennae is another character that one can use to distinguish the two species. Robust setae feature much more prevalently on the antennal article margins of *N. quadrispinosa*.

Schultz (1976) redescribed *N. spicata* from material collected from Antarctica. Schultz also assessed the illustration and description by Vanhöffen (1914) and created a new species *Pseudarachna vanhoeffeni* (incorrectly labelled new combination). This species was based on Vanhöffen's description, which stated that it only has one uropodal ramus. Examination of Vanhöffen's specimen revealed that the uropod is biramous, the exopod is minute, and may quite easily be overlooked. The name is considered to be a junior synonym of *N. spicata*.

Distribution. Antarctica, eastwards from the Prince Olav coast, Queen Maud Land to the Anvers Islands, including the areas of the Davis and Ross Seas, from 36.6–560 metres.

***Notopais spinosa* (Hodgson, 1902) (Figs 4.74–4.77)**

Echinozone spinosa Hodgson, 1902: 255–256, plates XXXVIII–XXXIX.— Monod, 1926: 23–25, figs 16–18.— Schultz, 1976: 5–8, figs 1–2.— Brandt, 1990: 216, fig. 2.

Material examined.— Syntype. Female (11.0 mm), off Cape Adare, Victoria Land, Antarctica, approximately 71°S, 168°E, 26 fathoms (47.5 metres), collected 1899, *Southern Cross* (BMNH 1901.12.13.7).

Additional material.— Female (10.0 mm, dissected), Balleny Islands, Antarctica, stn E220b, 66°28.2'S, 162°45.5'E, 9 February 1965, small Agassiz trawl, 371 m, USS *Glacier* (NIWA XXXX).

Description. Body about 2.1 times as long as greatest width (from spine tip to spine tip) of pereonite 2; widest at pereonite 3; cuticle calcified, lightly setose. Cephalon with 2 dorsal spines, anterolaterally with 2 pairs of small spines; posterolateral margins broadly rounded. Pereonites 1–5 anterior margins each with 4 spines; pereonites 2–4 each with pair of sub-lateral spines; pereonite 5 anterolateral margins of pereonites 1–4 with spines, pereonite 5 anterolateral margin indented, pereonites 6 and 7 anterolateral margins pointing towards cephalon; pereonites 6–7 with pair of widely spaced, small dorsal spines; pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with enlarged rounded medial rise with numerous long setae. Pleon 0.9 times as long as proximal width, lateral sides indent and posterior end coming to a rounded point, with scattered SS.

Antenna 1 damaged; article 1 elongate, 2.1 times as long as wide, mesial margin with 1 SRS, surface with 2 PNS and 1 SRS on bump, and 2 SS, 1 RS and 1 PNS, lateral margin with 11 long SS and 1 sub-marginal SS, distal margin with 1 PNS and 2 SRS; article 2 0.3 times as long article 1, 1.5 times as long as wide, with 2 PNS and 5 SRS; article 3 with 1 SS; article 4 with 2 PNS; from article 6, each article has 1 aesthetasc, many articles with an additional SS. Antenna 2 damaged; articles 1–3 more or less triangular; article 1 lateral margin with 2 SRS and with 6 SS; article 2 1.4 times as long as article 1, distolateral margin with 3 SRS, 3 long SS and 1 sub-marginal SS; article 3 2.1 times as long as article 1, scale with 2 SRS and 1 SS, distomesial margin with 3 SRS (in a clump); article 4 large, 1.9 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis reduced, rounded; spine row with 7 spines (on right mandible, unable to tell on left mandible); molar small, distally with 6 uni-serrate setae (on left mandibular molar, 3 on right). Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.0 times as wide as mesial lobe, distal margin with few fine SS 5 RS and 7 dentate RS, mesial lobe distally with many fine SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.1 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.5 times as wide as lateral lobe, margins and surface with fine SS, distally with 8 blunt SS, 6 toothed setae and 2 pectinate

setae. Maxilliped coxa square, 1.0 times as long as wide, 0.4 times as long as basis (including endite); basis elongate, 2.1 times as long as wide (including endite); endite with 3 coupling hooks, distally with 10 bi-serrate setae, 6 fan setae and many fine SS; palp article 1 rectangular, 0.3 times as long as basal endite; article 2 3.4 times as long as and 1.4 as wide as article 1, 1.6 times as wide as basal endite, lateral margin with 7 SS (1 more robust than others), surface with 6 distally pappose setae; article 3 2.2 times as long as and 1.0 times as wide as article 1, lateral margin with 1 SS, surface with 6 distally pappose setae, mesial margin with 26 distally pappose setae; article 4 1.6 times as long as and 0.4 as wide as article 1, distomesial margin with 16 distally pappose setae; article 5 narrow, 1.1 times as long as and 0.1 times as wide as article 1, with 7 SS and 1 robust pectinate seta; epipod 1.8 times as long as wide, 1.1 times as long as basis.

Pereopod 1 basis 4.1 times as long as wide, inferior margin with 2 long SS and 2 short SS; ischium 3.0 times as long as wide, inferior margin with 5 SS, lateral surface with 10 SS, superior margin with 1 SRS (at mid-point); merus 1.0 times as long as wide, inferior margin with 15 SS, lateral surface with 1 SS (almost at distal margin), distosuperior margin with 5 SS (in distal half); carpus 3.6 times as long as wide, inferior margin with 22 SS, superior margin with 3 SS; propodus 5.9 times as long as wide, inferior margin with 30 SS, lateral surface with 18 SS, superior margin with 8 SS (all towards distal end); dactylus 2.4 times as long as proximal width, superior margin with 3 SS, unguis damaged.

Pereopod 2 basis 3.1 times as long as wide, inferior margin with 20 SS, (lengths varying), superior margin with 16 SS (lengths varying); ischium 2.7 times as long as wide, inferior margin with 17 SS, 2 RS and 14 SRS, lateral surface with 3 small SS, superior margin with 14 long SS and 1 short SS; merus 1.4 times as long as wide, inferior margin with 20 SS (lengths varying), lateral surface with 1 long SS and 4 short SS, distosuperior margin with 8 SS (lengths varying); carpus 5.5 times as long as wide, inferior margin with 20 long RS, 4 SS and 5 SRS, lateral surface with 2 long SS (at distal end), superior margin with 1 distal pectinate seta and 33 SS; propodus 9.7 times as long as wide, inferior margin with 5 SRS, 16 RS and 3 SS, lateral surface with 18 scattered SS,

superior margin with 20 SS and 1 distal PNS; dactylus 9.7 times as long as proximal width, with 25 SS, unguis damaged.

Pereopod 5 basis 3.2 times as long as wide, inferior margin with 4 SRS and 18 long SS, lateral surface with 3 PNS, 1 SRS and 1 SS, superior margin with 7 SRS, 8 SS and 15 long plumose setae; ischium 2.3 times as long as wide, inferior margin with SS (lengths varying), lateral surface with 9 small SS; merus 1.0 times as long as wide, inferior margin with 2 SRS and 5 SS, lateral surface with 4 SS, distosuperior margin with 2 SS; carpus 1.1 times as long as wide, inferior margin with 3 SS, distosuperior margin with 2 SRS and 1 SS; propodus, 3.6 times as long as wide, distoinferior margin with 1 SS, lateral surface with 2 SS, superior margin with 1 long SS, 3 short SS and 1 PNS; dactylus 5.4 times as long as proximal width, with 14 SS.

Pereopod 6 basis 3.5 times as long as wide, inferior margin with 17 long SS and 19 SRS, lateral surface with 1 SS and 1 SRS (both in proximal half), superior margin with 4 SRS and 16 SS; ischium 2.5 times as long as wide, inferior margin with 15 SS, lateral surface with 15 scattered SS; merus 1.3 times as long as wide, inferior margin with 8 SS, lateral surface with 4 SS, distosuperior margin with 3 SS; carpus 1.3 times as long as wide, distosuperior margin with 1 SRS; propodus 4.6 times as long as wide, distosuperior margin with 1 long SS; dactylus 7.1 times as long as proximal width, with 14 SS, unguis damaged.

Pereopod 7 basis 4.1 times as long as wide, inferior margin with 7 SRS and 12 SS, distoinferior margin with 1 SRS and 3 SS (in clump), lateral surface with 6 SRS, superior margin with 6 SS and 4 SRS; ischium 2.7 times as long as wide, inferior margin with 11 long SS, lateral surface with 8 long SS; merus 1.1 times as long as wide, inferior margin with 10 SS, lateral surface with 5 SS, distosuperior margin with 2 SS; carpus 3.6 times as long as wide, distosuperior margin with 1 SRS; propodus 7.9 times as long as wide, superior margin with 4 small sub-marginal SS, distosuperior margin with 1 PNS; dactylus 7.8 times as long as proximal width, superior margin with 8 SS, unguis damaged.

Operculum approximately 1.5 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with

row of RS and few lightly plumose setae, proximally with 6 long RS, surface with many plumose setae, lateral margins with numerous plumose setae. Pleopod 3 exopod 1.1 times length of endopod, distally with 10 long plumose setae; endopod 2.0 times as long as wide, with 18 long plumose setae. Pleopod 4 exopod with 8 terminal long plumose setae; endopod oval, 1.4 times as long as wide. Pleopod 5 2.0 times as long as wide.

Uropod protopod 3.3 times as long as wide, distal end rounded, lateral margin provided with 14 SS and 23 long plumose setae, mesial margin with 5 plumose setae, surface with 6 scattered SS; exopod small, 0.1 times as long as protopod, 0.5 times as long as endopod, with 8 SS; endopod 0.2 times as long as protopod, with 4 PNS and 3 SS.

Remarks. *Notopais spinosa* is distinguished from all other *Notopais* species by a combination of: pereonite 5 margin with 4 spines; pereonites 6 and 7 each with pair of dorsal spines; ventral surface of pereonite 7 with enlarged rounded medial rise with numerous long setae; pereopod 5 basis with plumose setae; and the operculum covered in long plumose setae. It is similar to *Notopais spicata*, but, can be distinguished from this species by the presence of spines on pereonites 6 and 7 which are not present in *N. spicata*. *N. spinosa* has plumose setae on the carpus and propodus inferior margins, while in *N. spicata* plumose setae on these margins are absent. The operculum ventral surface has numerous plumose setae, while in *N. spicata*, the surface has only simple setae.

N. spinosa has been collected from several localities around the Antarctic and this is the first record of this species from the Ballemy Islands, an area which is close to the type locality.

Distribution. *N. spinosa* is known from Antarctica, from the Balleny Islands and east to the Weddell Sea, between 18–569 metres.

Notopais zealandica **Merrin, 2004 (Figs 4.78–4.80)**

Notopais zealandica Merrin, 2004b: 21–26, figs 8–10.

Material examined.— Holotype. Female (4.5 mm), Stn S150, Chatham Rise, New Zealand, 45°46.0’S, 174°24.5’E, 26 October 1979, epibenthic sled, 1640 m,

RV *Tangaroa* (NIWA 3303). Paratypes. 1 male (3.0 mm, part remaining only, pleon missing), 5 females (3.5, dissected; 3.5; 4.0; 4.5, dissected; 4.8 mm), Stn S153, Chatham Rise, New Zealand, 45°21.1'S, 173°35.8'E, 27 October 1979, epibenthic sled, 1386 m, RV *Tangaroa* (NIWA 3304).

Additional material.— 2 fragments, Stn S153, Chatham Rise, New Zealand, 45°21.1'S, 173°35.8'E, 27 October 1979, epibenthic sled, 1386 m, RV *Tangaroa* (NIWA 3331).

Description. Body 2.1 times as long as width of pereonite 2 (from spine to spine), widest at pereonite 5; cuticle not highly calcified, smooth. Cephalon smooth; anterior margins with few small SS; posterolateral margins broadly rounded; Pereonites 1–5 anterior margins with stiff SS; pereonite 5 with anterolateral margins rounded and blade-like overhang raised above pereonites anterior margin; anterolateral margins of pereonites 3, 4, 6 and 7 with small lobes.

Antenna 1 of 9 articles; article 1 rectangular, 1.6 times as long as wide, dorsal surface concave, mesial margin with 5 SS, surface with 1 PNS, distal margin with 5 RS, 2 SRS and 1 PNS; article 2 0.3 times as long as article 1, 1.8 times as long as wide (not including distal projection) with 2 RS, one on distal projection; article 4 with 3 SS; article 6 with 1 distal aesthetasc; terminal article with 3 small SS. Antenna 2 articles 1–3 more or less triangular; article 2 1.1 times as long as article 1, distolateral margin with 1 SRS surface with 1 SS; article 3 1.4 times as long as article 1, distal margin with 5 peripheral long RS and 1 SRS; article 4 small, about half the size of article 3, 1.1 times as long as article 1, not ornamented. Pleon 0.5 times as long as proximal width and posterior tip rounded.

Mandible spine row and lacinia mobilis absent; molar small, terminated by 2 uni-serrate setae and 3 SS (on right molar terminated with 4 uni-serrate setae). Maxilla 1 lateral lobe 2.1 times as wide as mesial lobe, lateral and mesial margins with fine SS, distal margin with 6 RS, 3 dentate RS and 3 semi-plumose RS; mesial lobe with fine SS on margins, distally with 6 SS and 2 long pectinate setae. Maxilla 2 lateral lobe with scattered fine SS, distally with 4 long SS;

middle lobe 1.2 times as wide as lateral lobe, distally with 3 long SS; mesial lobe 2.0 times as wide as lateral lobe, margins with fine SS, distally with 7 SS, 4 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, small, 0.8 times as long as wide, 0.2 times as long as basis (including endite); basis elongate 2.9 times as long as wide (including endite), with 2 SS, distolateral margin with 1 SS; endite with 4 coupling hooks, distally with 4 SS, 3 fan setae and many fine SS; palp article 1 wide, shortest, 2.0 times as long as basal endite, trapezoid, distolateral margin with 2 SS, distomesial margin with 1 SS; article 2 3.1 times as long as and 1.4 times as wide as article 1, 2.0 times as wide as basal endite, lateral margin with cuticular scales and 3 SS, surface with 1 SS, mesial margin with 3 distally pappose setae and 1 SS; article 3 1.7 times as long as wide and 0.9 times as wide as article 1, lateral margin with 2 SS, mesial margin with 4 SS and 15 distally pappose setae; article 4 rectangular, 0.4 times as long as article 1, lateral margin with 1 SS, distal margin with 1 SS and 3 distally pappose setae; article 5 rectangular, small, narrowest article, 0.8 times as long as and 0.1 times as wide as article 1, with 5 terminal SS; epipod semi-oval, 2.1 times as long as wide, 1.2 times as long as basis, with numerous marginal cuticular scales.

Pereopod 1 basis 6.3 times as long as wide, inferior margin with cuticular scales, 5 SS and 1 distal SRS, lateral surface with 2 distal SS, superior margin with 3 SS; ischium 3.5 times as long as wide, inferior margin with 4 SS, lateral surface with 2 SRS and 1 SS, superior margin with 2 distal SS, 2 short RS and 1 long RS at midpoint; merus 1.2 times as long as wide, inferior margin with 5 SS, distosuperior margin with 3 SS; carpus 4.6 times as long as wide, inferior margin with 4 long SS (2+2 on proximal half), superior margin with 5 SS (2 in distal corner); propodus 5.3 times as long as wide, inferior margin with 6 SS, lateral surface with 8 scattered SS, superior margin with 2 SS (both in proximal half); dactylus 2.3 times as long as proximal width, superior margin with 4 SS.

Pereopod 5 basis 3.5 times as long as wide, inferior margin with 3 SRS and 4 SS all in loose cluster, distal corner with 1 SRS and 1 SS; ischium 2.2 times as long as wide, inferior margin with 9 SS and 1 sub-marginal SS; merus 1.2 times as long as wide, inferior margin with 7 SS; carpus 0.9 times as long as wide, lateral surface with 2 SS, distosuperior margin with 1 SRS; propodus 2.6

times as long as wide, superior margin with 7 sub-marginal SS and 1 PNS on distal corner; dactylus 5.7 times as long as proximal width, distosuperior margin with 4 SS.

Pereopod 6 basis 3.5 times as long as wide, inferior margin with 10 SS (grouped in 2+7+1) and 1 sub-marginal distal RS, distal margin with 5 SRS (grouped in 4+1); ischium 2.1 times as long as wide, inferior margin with 11 evenly spaced, marginal SS and 5 sub-marginal SS; merus 1.3 times as long as wide, inferior margin with 5 SS; carpus 0.9 times as long as wide, lateral surface with 4 SS; propodus 2.8 times as long as wide, superior margin with 10 sub-marginal, evenly spaced SS; dactylus 6.7 times as long as proximal width; unguis absent.

Operculum 2.5 times as long as proximal width, distal end with medial slit and veined lamellar extension, proximal margin of median keel and keel itself provided with robust SS (proximal margin 7+8), distal surface with numerous scattered SS, anterior margins with 13 SS, 6 on right and 7 on left margin, lateral margins with numerous plumose setae. Pleopod 3 exopod, 1.3 times as long as endopod, proximolateral margin with 6 SS set amongst continuous fine SS, distally with 4 long plumose setae; endopod 1.4 times as long as wide, with 6 long plumose setae. Pleopod 4 exopod with 1 apical long plumose setae; endopod sub-circular, 1.1 times as long as wide. Pleopod 5 1.5 times as long as wide.

Uropod protopod 2.6 times as long as wide, margins sub-parallel, distomesial bulge produced, not extending past endopod, with 1 plumose setae and 1 SS, lateral margin with 8 plumose setae and 11 SS, mesial margin with 4 plumose setae, surface with 9 scattered SS; exopod small, 0.2 times as long as protopod, 0.6 times as long as endopod, with 3 SS; endopod 0.3 times as long as protopod with 1 SS.

Remarks. *Notopais zealandica* is unique in that all pereonites lack anterior spines on their margins and instead are provided with stiff simple setae, similar to that seen on pereonite 5 of *N. beddardi*. *N. zealandica* is also the only species in this genus without spines on the cephalon, and has a distinct blade-like extension raised above the anterior margin of pereonite 5.

Distribution. Chatham Rise, New Zealand, at depths between 1386–1640 metres.

Etymology. N. zealandica is named after New Zealand, as this species occurs within its waters.

***Nyctobadistes* n. gen.**

Type species. *Nyctobadistes hamatus* n. sp., here designated.

Diagnosis. Cephalic frons wide, rectangular; cephalic anterior flanges absent. Pereonites 1–4 anterior margins with spines, apical seta absent; pereonites 5–7 laterally distinct from each other, together less streamlined, natasome somewhat reduced, without lateral extensions. Pleon in dorsal view longer than wide, dorsal spines present, anterolateral spines absent. Antennae positioned closely together; antenna 1 not small, article 1 lateral flange present. antenna 2 article 1 with no anterolateral spine. Mandible lacinia mobilis present, reduced; spine row present; mandibular palp present, short; mandibular fossa angular, sub-horizontal across mandible. Pereopod 2 ambulatory, not enlarged; natatory pereopods not very expanded, carpus, elongate; dactyli of natatory pereopods narrowing distally. Pleopod 4 exopod with more than 1 plumose seta. Uropods unknown.

Species included. Nyctobadistes hamatus n. sp.

Remarks. Nyctobadistes n. gen. is distinguished by the combination of: the reduced natasome; pereonites 5–7 are laterally distinct, rounded, without lateral extensions; dorsal body spines without apical setae; antenna 1 article 1 with lateral extension; and natatory pereopods not expanded.

Nyctobadistes is in some ways similar to *Bathybadistes* as both genera have a natasome which is reduced from the streamlined one seen in *Ilyarachna*. *Nyctobadistes*, but, can be distinguished from *Bathybadistes* as *Nyctobadistes* lacks lateral extensions on the natasomal pereonites, does not have apical setae

on the dorsal body spines and the anterolateral margin of the pleon lacks the spine and apical seta which is present on *Bathybadistes*.

At present, *Nyctobadistes* is only known from the type species, *Nyctobadistes hamatus* which is located off Freycinet Peninsula, Tasmania, Australia, between 720–800 metres.

Etymology. *Nyctobadistes* means night walker and is derived from the Greek words nyktos (night) and badistes (walker).

***Nyctobadistes hamatus* n. sp. (Figs 4.81–4.83)**

Material examined.— Holotype. Male (3.2 mm), off Freycinet Peninsula, Tas., Australia, stn SLOPE 46, 42°0.20'S, 148°37.70'E, 27 July 1986, WHOI epibenthic sled, 720 m, RV *Franklin*, coarse shelly sand (NMV ex J18840). Paratypes. 1 female (5.0 mm), 1 male (3.0 mm), 2 fragments, type locality (NMV ex J18840). 1 male (3.6 mm), off Freycinet Peninsula, Tas., Australia, stn SLOPE 45, 42°2.20'S, 148°38.7'E, 27 July 1986, WHOI epibenthic sled, 800 m, RV *Franklin,* coarse shelly sand (NMV J18839).

Description. Male. Body about 2.4 times as long as greatest width of pereonite 2; widest at pereonite 2; cuticle calcified, smooth. Cephalon with 2 dorsal spines, anterolaterally with 4 pairs of smaller spines; posterolateral margins rounded; Pereonites 1–3 with 6 spines (2 large central ones, and 2 smaller pairs); pereonites 4 and 5 with 4 spines, pereonite 6 with 2 spines, pereonite 7 with 3 spines; anterolateral margins of pereonites 1 with spines only; pereonite 6 ventrally with 4 spines; pereonite 7 ventrally with two small spines. Pleonite 1 with 1 pair of spines. Pleon 1.5 times as long as proximal width, lateral sides narrowing slightly, posterior end square, with pair of tubercles.

Antenna 1 of 21 articles; article 1 1.4 as long as wide, with 2 RS and 1 distal PNS; article 2 1.7 times as long as wide, distomesial margin with 1 SS and 1 PNS; article 4 mesial margin with 2 PNS; from article 8 onwards, each article has 1 aesthetasc and many articles with additional SS.

Pereopod 6 basis 4.6 times as long as wide, inferior margin with 18 SS, lateral surface with 1 SS, superior margin with 3 PNS and 7 SS; ischium 4.2 times as long as wide, inferior margin with 21 SS, superior margin with 5 SS, plumose setae sparsely plumose; merus 1.6 times as long as wide, inferior margin with 2 SS, distosuperior margin with 9 SS (lengths varying); carpus 3.8 times as long as wide, inferior margin with 4 additional SS, lateral surface with 1 SS, superior margin with 1 SRS; propodus 7.5 times as long as wide, inferior margin with 2 SS, plumose setae are sparsely plumose on inferior and superior margins, distosuperior margin with 3 SS and 1 PNS; dactylus 8.1 times as long as proximal width, distosuperior margin with 2 SS.

Pereopod 7 basis 5.8 times as long as wide, inferior margin with 11 SS and 1 RS, superior margin with 1 PNS and 5 SS; ischium 3.8 times as long as wide, inferior margin with 11 SS, lateral surface with 1 SS, superior margin with 2 sparsely plumose setae; merus 1.5 times as long as wide, inferior margin with 7 SS, distosuperior margin with 2 SS; carpus 4.4 times as long as wide, inferior margin plumose setae sparsely plumose, superior margin with 4 SS (3 sub-marginal); propodus 10.0 times as long as wide, distoinferior margin with 1 SS, superior margin with 5 SS (4 in clump at distal end, 1 very long); dactylus approximately 7.3 times as long as proximal width, superior margin with 3 setae SS.

Pleopod 1 5.3 times as long as proximal width, lateral margins indent 0.7 from proximal end, either side of central margin with 9 SS, 5 RS (all broken), distally with 13 SS. Pleopod 2 protopod 3.6 times as long as wide, lateral margin with 6 SS (proximal half) and row of 9 plumose setae, surface with 16 scattered SS, distally with lamellar extension and few fine SS, mesial margin with 2 plumose setae; exopod elongate, 0.1 times as long as protopod, with fine SS; stylet short, 0.6 times as long as protopod, not hooking up into proximal part of protopod; sperm duct 0.5 times as long as stylet.

Female. Antenna 1 of 6 articles; article 1 elongate, 2.1 times as long as wide, distal end triangular, mesial margin with 1 SS, mesial square-like extension with 3 blunt RS and 1 PNS, surface with 1 PNS, lateral margin with 1 SS; article 2 elongate, 0.4 times as long article 1, 2.9 times as long as wide, with 2 SS and 1

PNS; article 4 with 2 PNS; terminal article with 2 SS and 1 distal aesthetasc. Antenna 2 damaged; article 1 triangular, lateral margin with 1 RS; article 2 1.7 times as long as article 1, with short spine; article 3 2.2 times as long as article 1, scale with 5 SS, distomesial margin with 2 RS and 1 SS; article 4 1.5 times as long as article 1, with 1 SS.

Mandible lacinia mobilis reduced and smooth, rounded; spine row damaged on left mandible, right mandible spine row with 4 spines; molar large, distally with 1 SS (on left mandible, absent on right) and 4 bi-serrate setae; mandibular palp small, not extending beyond incisor, article 1 with 3 SS, article 3 with 3 terminal SS. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.1 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 7 pectinate RS and 2 pectinate dentate RS, mesial lobe distally with 5 SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.4 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 3.4 times as wide as lateral lobe, margins and surface with fine SS proximally, mesial margin also with 17 long bi-serrate setae, distally with 5 blunt SS, 5 toothed setae and 1 pectinate setae (broken off). Maxilliped coxa rectangular, 1.1 times as long as wide, 0.4 times as long as basis (including endite); basis elongate, 2.9 times as long as wide (including endite), with 11 SS (all below endite); endite with 5 coupling hooks, distally with 4 blunt SS, 3 sub-marginal SS, 6 fan setae and many fine SS; palp article 1 wide, 0.7 times as long as basal endite, rectangular, distolateral margin with 4 SS, distomesial margin with 1 SS; article 2 2.8 times as long as and 1.2 as wide as article 1, 1.3 times as wide as basal endite, lateral margin with 6 SS, mesial margin with 8 distally pappose setae; article 3 1.4 times as long as and 0.9 times as wide as article 1, lateral margin with 1 SS, surface with 3 SS and 2 distally pappose setae, mesial margin with 16 distally pappose setae; article 4 0.7 times as long as and 0.4 as wide as article 1, lateral margin with 2 SS, distal margin with 1 SS and 7 distally pappose setae; article 5 narrow, 0.8 times as long as and 0.2 times as wide as article 1, with 4 SS and 2 distally pappose setae; epipod 1.7 times as long as wide, 1.1 times as long as basis, margins with cuticular scales, surface with scattered SS.

Pereopod 1 basis 3.8 times as long as wide, inferior margin with 9 SRS and 1 SS, superior margin with 11 SS and 1 PNS; ischium 2.6 times as long as wide, inferior margin with 7 SS, lateral surface with 5 SS, superior margin with 2 RS; merus 1.0 times as long as wide, inferior margin with 9 RS, distosuperior margin with 3 SS; carpus 3.5 times as long as wide, inferior margin with 10 RS and 7 SS, superior margin with 1 SS; propodus 5.7 times as long as wide, inferior margin with 7 SS, lateral surface with 2 SS, distosuperior margin with 2 SS; dactylus 2.7 times as long as proximal width, superior margin with 3 SS.

Operculum approximately 2.9 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with row of RS and SS, distal surface with 5 plumose setae (at least, in row, left side only, right side missing), surface with scattered SS, margins anterolaterally with 11 SS, laterally with numerous plumose setae. Pleopod 3 exopod 1.1 times length of endopod, distally with 7 long plumose setae (all broken) and 1 distal SS; endopod 2.0 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod with 3 terminal long plumose setae; endopod oval, 1.7 times as long as wide. Pleopod 5 2.2 times as long as wide.

Remarks. See remarks section for genus.

Distribution. Of Freycinet Peninsula, Tasmania, Australia, between the depths of 720–800 metres.

Etymology. Hamatus is a Latin word meaning with hooks; here alluding to the hook like spines on the ventral side of pereonite 6.

***Pseudarachna* Sars, 1897**

Mesostenus Sars, 1864: 9 (part).

Pseudarachna.— Sars, 1897b: 142.— Nierstrasz and Schuurmans-Stekhoven, 1930: 129.— Kussakin, 2003: 261.

Not *Pseudarachna*. — Schultz 1976: 13.

Type species. *Mesostenus hirsutus* Sars, 1864; by monotypy.

Diagnosis. Cephalic frons enlarged, broad, semi-circular, without defined ridge around antennae; cephalon anterior flanges absent. Body compact; pereonites 1–4 not short or compact, dorsal spines present, apical setae present. Pereonite 2 largest; pereonites 5–7, lateral margins not narrow, natasome not reduced. Pleon anterolateral margins without spine. Antennae positioned widely apart; antenna 1 small, article 1 with lateral flange; antenna 2 article 1 with no anterolateral spine. Mandible lacinia mobilis, spine row and palp all absent; mandibular fossa angular, sub-horizontal across mandible. Pereopod 2 elongate, robust; ischium compact, wider than other articles; pereopods 5 and 6 carpus paddle shaped; dactyli of natatory pereopods flattened, somewhat expanded. Pleopod 4 exopod with more than 1 plumose seta. Uropods uniramous.

Species included. *Pseudarachna hirsuta* (Sars, 1864) and *Pseudarachna nohinohi* n. sp.

Remarks. *Pseudarachna* has many unique apomorphies, the most notable being the enlarged, semi-circular cephalic frons, the widely spaced antennae, the small antenna 1, enlarged pereonite 2 and a robust and enlarged pereopod 2 with a wide, compact ischium. *Pseudarachna* is easily distinguished by these characters from other closely related genera such as *Ilyarachna* and *Echinozone*.

Males are not known for this genus, and there is no data specific on sexual dimorphism.

Distribution. North Atlantic, from western Ireland to Denmark (Wolff 1962), at depths between 50–478 metres (Svavarsson *et al*. 1993); off eastern Australia at approximately 36° south off and, Bass Strait at 38° south off Point Hicks (both records of undescribed mancas) at depths between 960–1277 metres; Challenger Plateau, west of the South Island, New Zealand; at depths between 1005–1463 metres.

***Pseudarachna nohinohi* n. sp. (Figs 4.84–4.86)**

Material examined.— All Challenger Plateau, Tasman Sea, New Zealand. Holotype. Ovigerous female (1.7 mm), stn P929, 40°42.8'S, 167°56.0'E, 18 April 1980, epibenthic sled, 1029 m, RV *Tangaroa* (NIWA XXXX). Paratypes. 2 females (2 mm [dissected], 2 mm), 1 fragment, stn P941, 41°15.2'S, 167°07.2'E, 23 April 1980, epibenthic sled, 1463–1457 m, RV *Tangaroa* (NIWA XXXX); 2 females (1.7 mm, dissected; 2 mm, dissected), stn P927, 40°50.1'S, 168°14.8'E, 18 April 1980, epibenthic sled, 1009–1005 m, RV *Tangaroa* (NIWA XXXX).

Description. Body about 2.1 times as long as greatest width (from spine to spine) of pereonite 2; widest at pereonite 2; cuticle not highly calcified, lightly setose. Cephalon covered with many long setae, spines absent; posterolateral margins rounded. Pereonites 1–4 each with pair of anterior sub-marginal short spines. Pereonite 5 anterior margin smooth, anterolaterally square; anterolateral margins of pereonites 2–4 with pair of small spines, 6–7 rounded. Pereonite 7 ventrally with no ornamentation. Pleon as long as proximal width, dorsal surface sculptured, with rounded medial keel, posterior tip rounded, with scattered SS.

Antenna 1 of 7 articles; article 1 lateral flange reaching beyond article 2, 1.6 times as long as wide, lateral margin with 2 PNS (on lateral flange), distal margin with 1 PNS and 1 elongate SRS; article 2 rectangular, 0.4 times as long article 1, and 2.2 times as long as wide, with 4 distal PNS; article 6 with 1 distal aesthetasc; terminal article with 2 SS and distal aesthetasc. Antenna 2 damaged; article 1 margin smooth; article 2 2.0 times as long as article 1, with 1 SRS and 1 SS; article 3 2.8 times as long as article 1, with 2 SRS and 1 SS; article 4 elongate, 3.3 times as long as article 1, with no ornamentation; article 5 19.5 times as long as article 1, mesial margin with 12 SRS, surface with 3 SS, lateral margin with 5 SS and 11 SRS.

Mandible molar small, distally with 3 SS (on right molar, none on left). Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.1 times as wide as mesial lobe, distal margin with few fine SS, 5 RS, 3 dentate RS and 4 pectinate RS; mesial lobe distally with 5 SS and 2 long pectinate setae. Maxilla 2

lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 1.1 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.1 times as wide as lateral lobe, margins with fine SS, proximally, mesial margin with 3 elongate, lightly plumose setae; lateral lobe distally with 3 blunt SS, few fine SS, 1 toothed seta and 1 long pectinate seta. Maxilliped coxa rectangular, 1.1 times as long as wide, 0.5 times as long as basis (including endite); basis elongate, 2.4 times as long as wide (including endite); endite with 1 coupling hook (on right maxilliped, 2 on left), distally with 2 toothed setae, 5 fan setae and many fine SS; article 1 rectangular, 0.3 times as long as basal endite, cuticular scales present, with 1 SS each on distolateral and distomesial margin; article 2 3.7 times as long as and 1.3 as wide as article 1, 1.2 times as wide as basal endite, lateral margin with cuticular scales and 2 SS, mesial margin with 3 distally pappose setae and 1 SS; article 3 1.8 times as long as and 1.0 times as wide as article 1, lateral margin with 1 SS, mesial margin with 1 SS and 5 distally pappose setae; articles 4 and 5 rectangular; article 4, 1.4 times as long and 0.5 times as wide as article 1, distal margin with 3 SS (left maxilliped palp article 4 with 4 SS); article 5 with 4 terminal SS; left maxilliped palp article 5 0.8 times as long as and 0.5 times as wide as article 4, with 3 SS; epipod 2.2 times as long as wide, 1.4 times as long as basis, margins with many cuticular scales and 1 SS.

Pereopod 1 basis 6.0 times as long as wide, inferior margin with 2 weakly plumose setae, 4 SS (3 long) and 1 distal SRS, superior margin with 2 SS, 1 PNS and 1 long SRS; ischium 6.8 times as long as wide, inferior margin with 2 SS, superior margin with 2 SS and 2 SRS; merus 2.2 times as long as wide, inferior margin with 3 SS, distosuperior margin with 1 small SS; carpus 10.0 times as long as wide, inferior margin with 2 small SS, in proximal half; propodus 15.0 times as long as wide, distoinferior margin with 5 SS, distosuperior margin with 2 SS on distal margin; dactylus 4.9 times as long as proximal width, superior margin with 3 small SS.

Pereopod 2 basis 4.1 times as long as wide, inferior margin with 9 SS, superior margin with 5 SS and 1 PNS; ischium 1.2 times as long as wide, inferior margin with 2 SRS and 1 SS, distally with 14 SRS (8 on one side and 6 on

opposable surface), lateral surface with 4 SS (plus 1 SS on opposable surface), superior margin with 2 SS and 1 SRS; merus 1.4 times as long as wide, distoinferior corner with 4 SRS, distosuperior margin with 2 SS; carpus 4.1 times as long as wide, inferior margin with 1 SS and 7 long SRS, lateral surface with 1 PNS and 3 SS, opposable surface with 10 SRS, superior margin with 4 SS; propodus 3.8 times as long as wide, inferior margin with 4 SRS, opposable lateral surface with 3 SRS, distosuperior margin with 1 SRS and 1 SS on distal corner; dactylus 5.2 times as long as proximal width, with 2 robust SS and 5 SS.

Pereopod 5 basis 4.8 times as long as wide, inferior margin with 8 SS, lateral surface with 1 PNS, superior margin with 2 PNS and 3 SS; ischium 2.9 times as long as wide, inferior margin with 8 SS; merus as long as wide, inferior margin with 2 SS, distosuperior margin with 1 SS and 1 small plumose seta; carpus 1.3 times as long as wide, distosuperior corner with 2 SS; propodus 2.8 times as long as wide, lateral surface with 1 SS, distosuperior corner with 1 SS; dactylus 4.7 times as long as proximal width, distosuperior margin with 1 SS.

Pereopod 6 basis 6.1 times as long as wide, inferior margin with 3 sparsely plumose setae and 3 SS, lateral surface with 1 sparsely plumose seta and 2 PNS, opposable surface with 1 long SS, superior margin with 1 SS and 1 PNS; ischium 3.3 times as long as wide, inferior margin with 5 SS, opposable lateral surface with 2 SS; merus 1.5 times as long as wide, inferior margin with 5 SS, distosuperior margin with 2 SS; carpus 2.1 times as long as wide, lateral surface with 1 SS; propodus 3.5 times as long as wide, inferior margin with 1 distal SS, superior margin with 1 distal SS and 4 scale-like structures; dactylus 6.4 times as long as proximal width, superior margin with 4 SS in distal corner.

Pereopod 7 basis 5.4 times as long as wide, inferior margin with 3 plumose setae and 2 SS, opposable lateral surface with 2 SS, superior margin with 3 PNS; ischium 3.9 times as long as wide, inferior margin with 4 SS, opposable lateral surface with 1 SS; merus 1.8 times as long as wide, inferior margin with 4 SS, distosuperior margin with 1 SS; carpus 3.1 times as long as wide, lateral surface with 1 SS; propodus 11.0 times as long as wide, distoinferior corner with 1 SS, superior margin with 6 sub-marginal SS and

scale-like structures in proximal half, plumose setae absent; dactylus 7.0 times as long as proximal width, distosuperior margin with 5 SS.

Operculum 2.1 times as long as proximal width, medial keel wide, somewhat flattened with long lightly plumose setae on both sides, surface with numerous lightly plumose setae, distally with pair of SS, 8 heavily plumose setae, medial excision and veined lamellar extension. Pleopod 3 exopod 1.4 times length of endopod, distally with 3 long plumose setae; endopod 1.7 times as long as wide, with 3 long plumose setae. Pleopod 4 exopod distally with 2 long plumose setae; endopod oval, 1.5 times as long as wide. Pleopod 5 1.9 times as long as wide.

Uropod protopod 2.2 times as long as wide, oval, with distal bulb with 1 SS, lateral margin with 4 plumose setae and 3 SS, distal margin with 2 plumose setae and surface with 3 scattered SS; endopod 0.1 times as long as protopod, with at least 1 SS (3 sockets also present).

Remarks. *Pseudarachna nohinohi* n. sp. can be distinguished from the only other species in this genus, *Pseudarachna hirsuta*, by the carpus and propodus of pereopod 2 being more setose in *P. nohinohi* than in *P. hirsuta*; the lateral flange of antenna 1 article 1 is round (square in *P. hirsuta*) and reaches beyond article 2 (does not reach beyond article 2); and the uropod is less elongate (2.1 times as long as wide versus 2.8 times as long as wide in *P. hirsuta*), less setose on margins and has a distal bulb (absent).

Distribution. Known from the Challenger Plateau, Tasman Sea, off the west coast of New Zealand; at depths of 1029–1463 m.

Etymology. Nohinohi is a Māori word meaning little or small; noun in apposition.

Pseudarachna spp.

Manca (1.7 mm), off eastern Australia, 36°57.95’S, 150°22.0’E, 960–1050 m, (AM P62620). Manca 1 manca (1.2 mm), stn SLOPE 67, 67 km south of Point Hicks, from 38°23.95–78’S, 149°17.02–15.24’E, 1277–1119 m, GCB Poore *et al*., RV *Franklin*, fine mud (NMV J18885).

Remarks. Although these species, both distinct, are not described, the records provide additional distribution data for the genus, indicating that at least three species occur in the south-western Pacific region.

Chapter 5: Distribution patterns of the *Ilyarachna*-group

The phylogenetic relationships determined by the cladistic analysis of the *Ilyarachna*-group reveal some distinct distribution patterns within the group. Apart from the monotypic genera, no *Ilyarachna*-group genus is endemic to one part of the world's oceans, although some genera have restricted distributions. Two genera, *Notopais* and *Epikopais*, have a Southern Hemisphere distribution, and consist entirely of species from Australia, New Zealand and Antarctica. The clade of five *Echinozone* species defined as 'Group A' in Chapter 3 are all found exclusively in the north-west Pacific. *Aspidarachna*, *Bathybadistes*, *Ilyarachna* and *Pseudarachna* have representatives in both the Pacific and Atlantic Ocean. The cladistic analysis also indicates regional groupings of closely related species within *Bathybadistes* and *Ilyarachna*. In *Bathybadistes*, two sister species, *B. fragilis* and *B. andrewsi* are both from the southern hemisphere (Weddell Sea, Antarctica and Bellona Trough, Tasman Sea, respectively). Within *Ilyarachna*, there are several clades which show regional distributions. There are three North Atlantic clades (Fig. 5.1, clades 34, 40 and 47) and one largely south-west Pacific clade (Fig. 5.1, clade 41 with the exception of *I. bicornis* which is the only non south-west Pacific member of this clade).

Thistle (1980) discussed the distribution of several *Ilyarachna* species, attributing wide geographic and bathymetric ranges to several species. He found *I. antarctica* to be distributed in the Atlantic Ocean and Antarctica (Atlantic–Indian sectors; although this distribution included the then synonymised *I. bicornis*) at depths between 509–4426 metres. The distribution of *I. longicornis* was pan-Atlantic (excluding Antarctica), at depths between 55–5223 metres; and the distribution of *I. polita* was also pan-Atlantic (excluding the North American Basin), at depths between 216–4885 metres. The wide ranges attributed to these species, however, probably reflects Thistle's (1980) broad species concept and wide interpretation of variation (Wilson and Hessler 1987). For instance, the deep-sea asellote *Eurycope complanata* Bonnier, 1896 was once considered to have a range throughout the North Atlantic. Wilson (1983), however, found *E.*

complanata to comprise a species complex of at least twelve species, each with restricted distributions. This is also the case with all the apparently widespread *Ilyarachna* species reported by Thistle (1980). The results from the analysis in Chapter 3 also supports this view, as *I. bicornis* and *I. antarctica* are two distinct species in different clades, suggesting Thistle's large range of *I. antarctica* is actually a complex of similar species in the Atlantic (Fig. 5.1).

The group from the northern seas of the North Atlantic (an area that includes the Norwegian, Greenland, Iceland and North Polar Seas) includes six species of *Ilyarachna* with robust setae along the anterior margins of pereonites 1–4. Three of these species, *I. frami*, *I. dubia* and *I. bergendali* form a clade (clade 34; Fig 5.1). Five of the six species are endemic to the northern seas, with only *I. hirticeps* extending beyond these seas.

Svavarsson *et al.* (1993) found that the asellote composition in these northern seas is influenced by the Greenland–Iceland–Faeroe Ridge. Apparently, the ridge acts as a physical barrier, both in relation to depth and water flow, with only species known from depths shallower than the lowest saddle (850 metres at the Faeroe Bank Channel) being able to expand their range beyond these seas. In those species that are known from depths greater than the lowest saddle, endemism was higher. This pattern is seen in the *Ilyarachna*-group, where the known deeper occurring species of the Northern Atlantic are endemic, whereas the species known from shallower depths range beyond the ridge. Based on the low generic diversity and a low number of species within genera, Svavarsson *et al.* (1993) also suggest that the fauna of the North Atlantic is likely to be young.

Within the major *Ilyarachna* clade (Fig. 5.1; clade 32), the results suggest that they have a possible North Atlantic origin, as the basal taxa of this clade are from this region, with the Antarctic, Australian and New Zealand species amongst the more derived. This is entirely possible, as the Atlantic Ocean formed between the Jurassic and the Cretaceous periods (Press and Siever 1982) and although the Asellota lack a fossil record, it is thought to be of at least Carboniferous in age (Wilson 1998). Ocean currents moving into the Atlantic, therefore, could have played an important role in the dispersal of a precursor to *Ilyarachna* within this ocean. *Ilyarachna*-group isopods have flattened, paddle

shaped carpi and propodi of pereopods 5–7, which enables them to swim. The extent of swimming for general locomotion is not known for most species of the *Ilyarachna*-group (see Chapter 3), though it is probably used as an escape mechanism (Hessler and Strömberg 1989). It is plausible that movement into the water column, and subsequent advection, has assisted dispersal of an *Ilyarachna* ancestor within the Atlantic and subsequently to other parts of the world, a hypothesis which has also been postulated by Brandt (2005) for the dispersal of southern ocean fauna into other oceanic basins.

Notopais is well represented in Antarctica and its known range extends north to the south-east continental slope of Australia and to the Chatham Rise east of New Zealand. The analysis suggests that *Notopais* has an Antarctic origin as the three basal species of the clade (clade 24) are Antarctic, while the Australian and New Zealand species are more derived.

Within the waters surrounding south-eastern Australia and New Zealand, *Notopais* and *Ilyarachna* are the best represented genera of all the *Ilyarachna*-group. The analysis, however, does not suggest a clear dispersal pattern for either genus within this region.

West to east dispersal of natatory species, and consequent speciation, has probably also been assisted by the establishment of the circumpolar current around Antarctica at the end of the Oligocene (Barker and Burrell 1977, Cooper and Milliner 1993). Two species of *Notopais*, *N. spicata* and *N. spinosa*, have wide distributions along the Antarctic coast (see Chapter 4). It is plausible that the swimming ability and movement into the water column has accelerated dispersal along the Antarctic coast. It is also likely that swimming ability and movement into the water column has most likely influenced the known distribution of several species in south-eastern Australia and New Zealand. *Notopais likros* has a known distribution from off Port Jackson, New South Wales to Bass Strait; *Ilyarachna flindersi* has a known distribution form Nowra, New South Wales to Flinders Canyon in Bass Strait; and *Ilyarachna aculeatus* has a known range from the north-west slope of the North Island of New Zealand, to the Chatham Rise, east of the South Island of New Zealand (see Chapter 4).

The likely swimming ability of *Ilyarachna*-group ancestors has probably made an important contribution to the present, near-cosmopolitan distribution of this group.

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Figure 1.1 General anatomy of the Ilyarachninae. A, *Ilyarachna longicornis*, modified after Sars, 1897b; B, a typical cephalon of the Ilyarachninae, modified after Wilson, 1989; C, pereopod 3 of *Ilyarachna longicornis*, modified after Sars, 1897b.

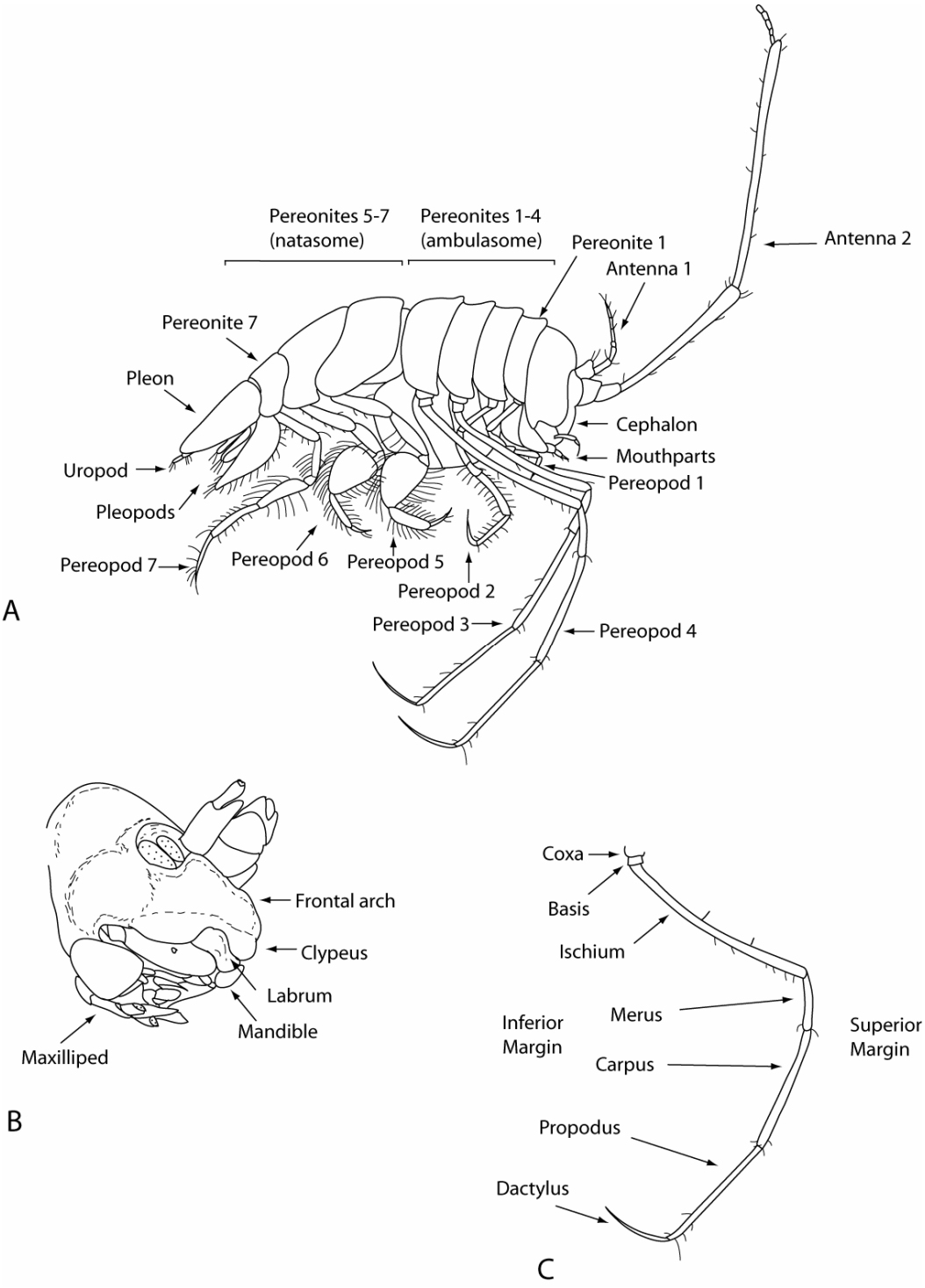
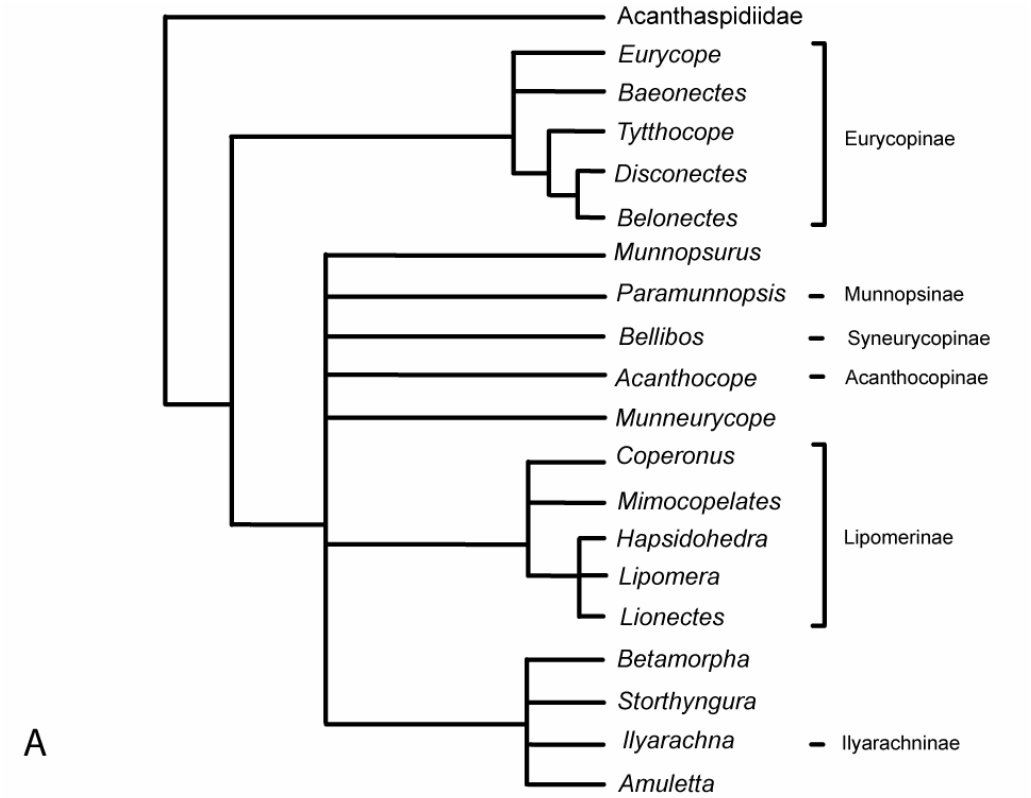

Pereonites 5-7
(natasome)
Pereonites 1-4
(ambulasome)
Pereonite 1
Antenna 2
Antenna 1
Pereonite 7
Pleon
Cephalon
Mouthparts
Uropod
Pereopod 1
Pleopods
Pereopod 7
Pereopod 6
Pereopod 5
Pereopod 2
A
Pereopod 3
Pereopod 4
Frontal arch
Clypeus
Labrum
Mandible
Maxilliped
B
Coxa
Basis
Ischium
Inferior
Margin
Merus
Superior
Margin
Carpus
Propodus
Dactylus
C

Figure 2.1 A, Wilson's (1989) strict consensus tree of the Munnopsidae generated by a successive character weighting analysis, modified after Wilson 1989; B, Wägele's (1989) tree on the relationships within the Munnopsidae (numbers in original), after Wägele, 1989.


Acanthaspidiidae
Eurycope
Baeonectes
Tytthocope
Disconectes
Belonectes
Eurycopinae
Munnopsurus
Paramunnopsis
Munnopsinae
Bellibos
Syneurycopinae
Acanthocope
Acanthocopinae
Munneurycope
Coperonus
Mimocopelates
Hapsidohedra
Lipomera
Lionectes
Lipomerinae
Betamorpha
Storthyngura
Ilyarachna
Ilyarachninae
Amuletta
A

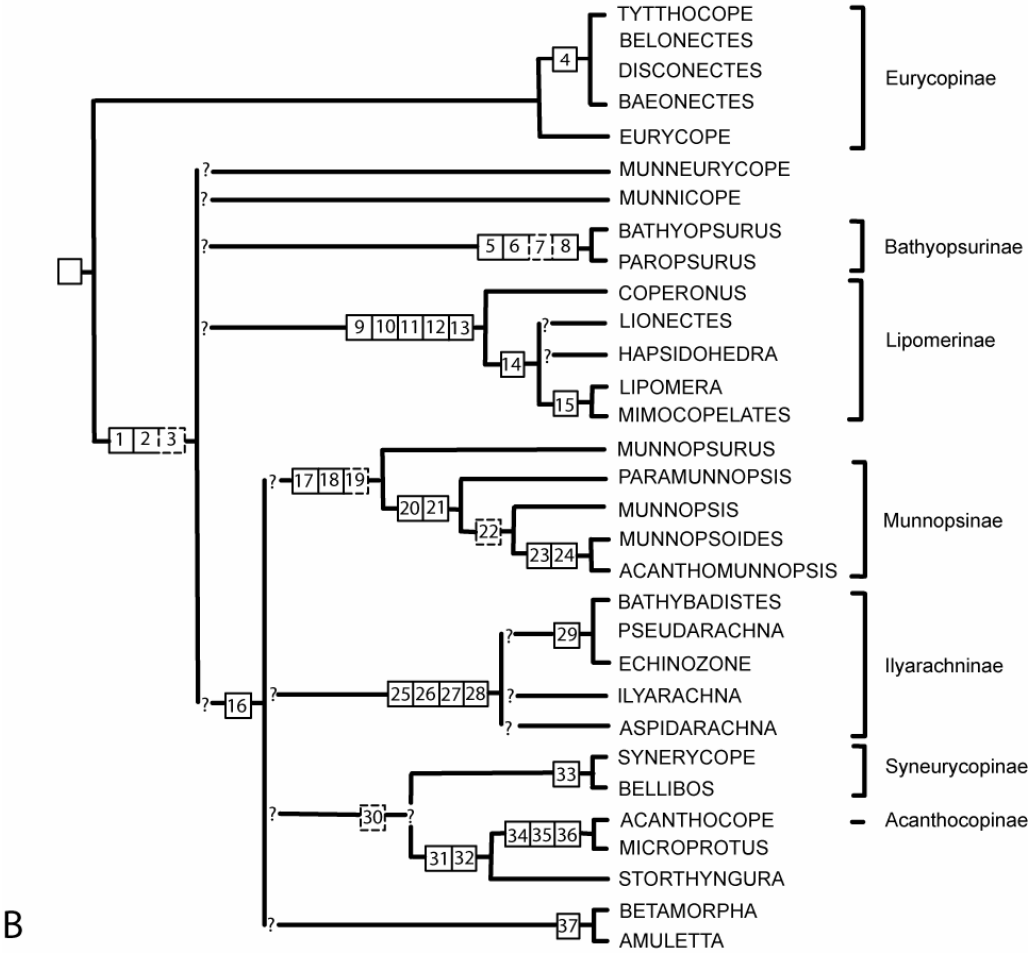

TYTTHOCOPE
BELONECTES
DISCONECTES
BAEONECTES
EURYCOPE
Eurycopinae
MUNNEURYCOPE
MUNNICOPE
BATHYOPSURUS
PAROPSURUS
Bathyopsurinae
COPERONUS
LIONECTES
HAPSIDOHEDRA
LIPOMERA
MIMOCOPELATES
Lipomerinae
MUNNOPSURUS
PARAMUNNOPSIS
MUNNOPSIS
MUNNOPSOIDES
ACANTHOMUNNOPSIS
Munnopsinae
BATHYBADISTES
PSEUDARACHNA
ECHINOZONE
ILYARACHNA
ASPIDARACHNA
Ilyarachninae
SYNERYCOPE
BELLIBOS
Syneurycopinae
ACANTHOCOPE
MICROPROTUS
STORTHYNGURA
Acanthocopinae
BETAMORPHA
AMULETTA
B

Figure 2.2 A, *Eurycope*, cephalon, after Wilson 1989; B, *Paramunnopsis*, cephalon, after Wilson 1989; C, *Munnopsurus*, cephalon, after Wilson, 1989; D, *Ilyarachna*, cephalon, after Wilson 1989; E, *Coperonus*, cephalon, after Wilson 1989; F, *Sursumura aberrata*, cephalon, modified after Malyutina 2003b; G, *Disconectes phalangium*, lateral view, modified after Wilson and Hessler 1981; H, *Munnopsis typica*, dorsal view, modified after Sars 1897b; I, *Paropsurus giganteus*, dorsal view of pereonites and pleotelson, modified after Wolff 1962; J, *Bathybadistes andrewsi*, dorsal view of pereonites 3–7 and pleotelson; K, *Tytthocope megalura*, lateral view of posterior pereonites and pleotelson, modified after Wilson and Hessler 1981; if = incipient frontal arch, f = frontal arch; c = clypeus.

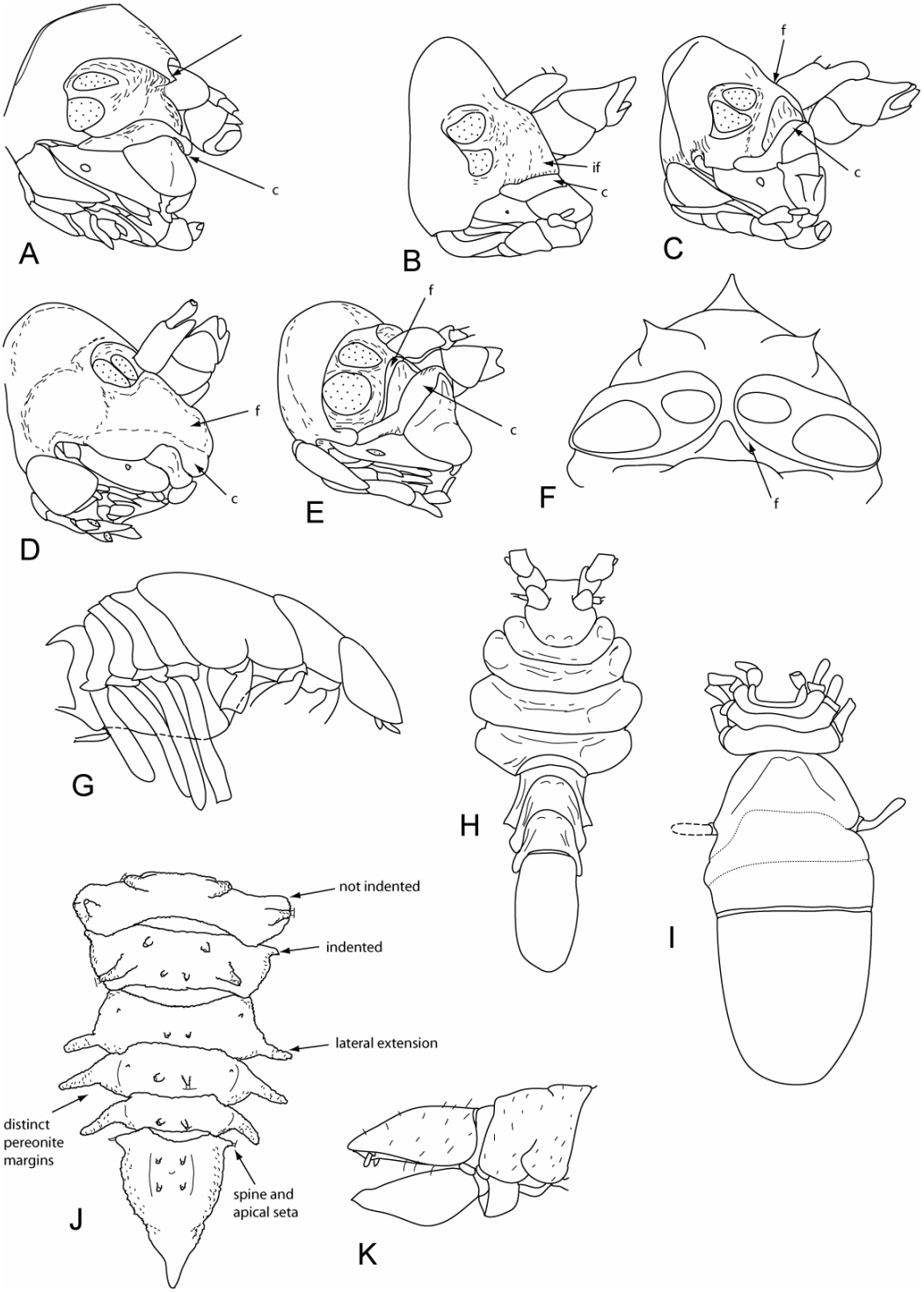

A
c
B
if
c
C
f
c
D
f
c
E
f
c
F
f
G
H
I
J
not indented
indented
lateral extension
distinct
pereonite
margins
spine and
apical seta
K

Figure 2.3 A, *Echinozone venusta* dorsal view of posterior pereonites and pleotelson, modified after Birstein 1971; B, *Mimocopelates anchibraziliensis*, dorsal view of posterior pereonites and pleotelson, modified after Wilson 1989; C, *Bellibos buzwilsoni*, antenna 1, modified after Haugness and Hessler 1979; D, *Tytthocope megalura*, antenna 1, modified after Wilson and Hessler 1981; E, *Sursumura aberrata*, antennae, modified after Malyutina 2003b; F, *Sursumura aberrata*, antenna 1, modified after Malyutina 2003b; G, *Eurycope diadela* Wilson, 1982, antenna 1, modified after Wilson 1982; H, *Bathybadistes andrewsi*, antenna 1, modified; I, *Pseudomunnopsis beddardi*, antennae, modified after Tattersall 1905b; J, *Vanhoeffenura myriamae* (George and Hinton, 1982); antenna 1, modified after Malyutina 2003b.

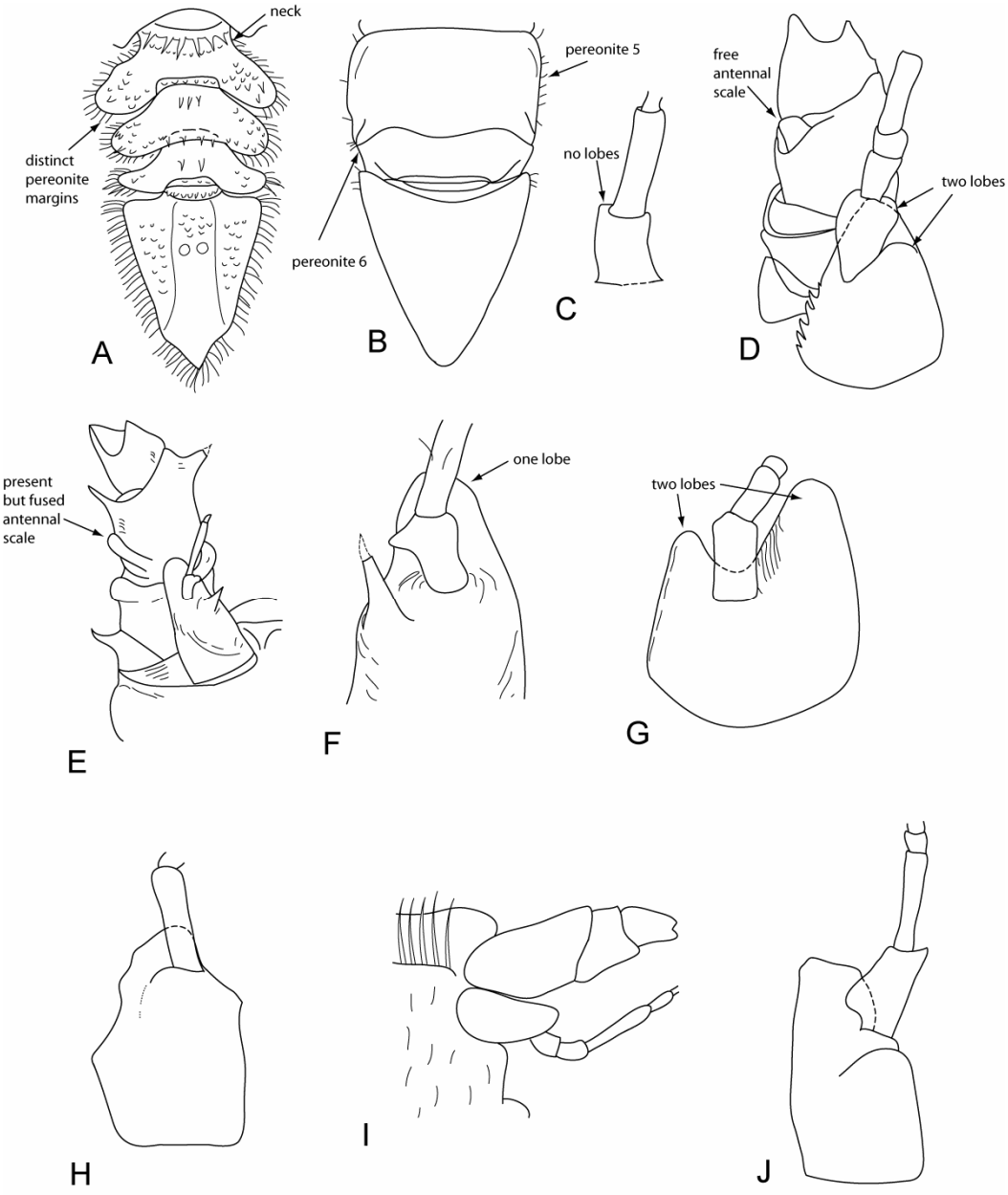

neck
distinct pereonite margins
A
pereonite 5
pereonite 6
B
no lobes
C
free antennal scale
two lobes
D
present but fused antennal scale
E
one lobe
F
two lobes
G
H
I
J

Figure 2.4 A, *Microprotus caecus* Richardson, 1910a, antennae, modified after Wilson *et al*. 1989; B, *Notopais euaxos*, antenna 2, modified; C, *Notopais euaxos*, mandible; D, *Bellibos buzwilsoni*, mandibular palp, modified after Haugness and Hessler 1979; E, *Vanhoeffenura myriamae*, mandible, after Malyutina, 2003b; F, *Munnopsis typica*, mandibular palp article 3, modified after Sars, 1897b; G, *Belonectes parvus*, mandibular palp, modified after Wilson and Hessler 1981; H, *Bathybadistes andrewsi*, mandibular palp, modified; I, *Vanhoeffenura georgei* Malyutina, 2003, maxilliped, modified after Malyutina 2003b; J, *Syneurycope parallela*, maxilliped, modified after Haugness and Hessler 1979.

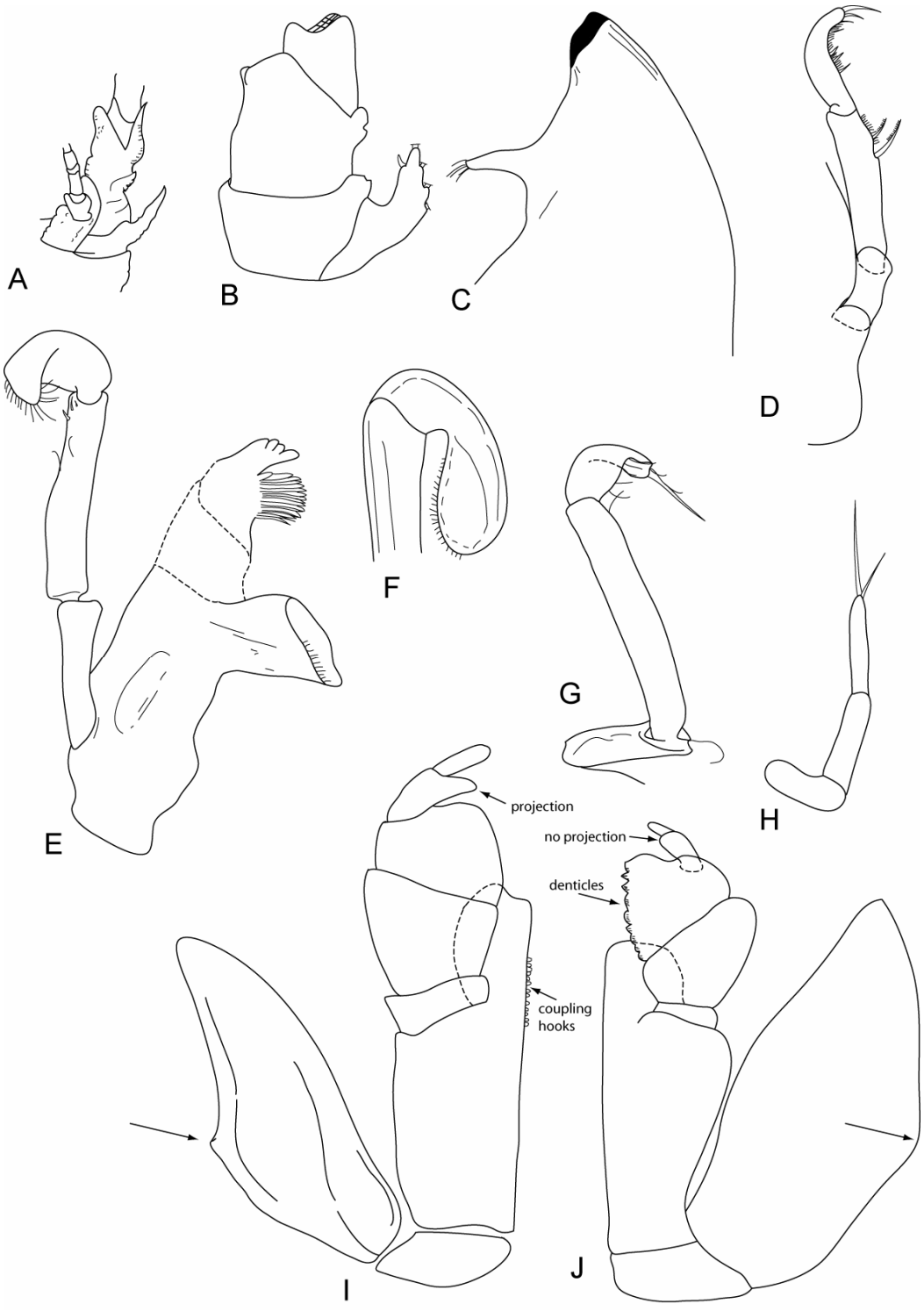

A
B
C
D
E
F
G
H
projection
no projection
denticles
coupling hooks
I
J

Figure 2.5 A, *Eurycope sandersi* Wilson, 1982, maxilliped, modified after Wilson 1982; B, *Mimocopelates longipes* Wilson, 1989, maxilliped, modified after Wilson 1989; C, *Bathybadistes andrewsi*, pereopod 1, modified; D, *Echinozone venusta*, pereopod 1, modified after Birstein 1971; E, *Lipomera knorrae* Wilson, 1989, pereopod 5, modified after Wilson 1989; F, *Munnopsis typica*, pereopod 5, modified after Sars, 1897b; G, *Storthyngurella hirsuta*, dorsal view of pleon, modified after Malyutina 1999b; H, *Microprotus caecus*, dorsal view of pleon, modified after Wilson *et al*. 1989; I, *Storthyngura phyllosoma*, dorsal view of pleon, modified after Just 2001; J, *Vanhoeffenura myriamae*, lateral view of pleon and operculum showing spine, modified after Malyutina, 2003b.

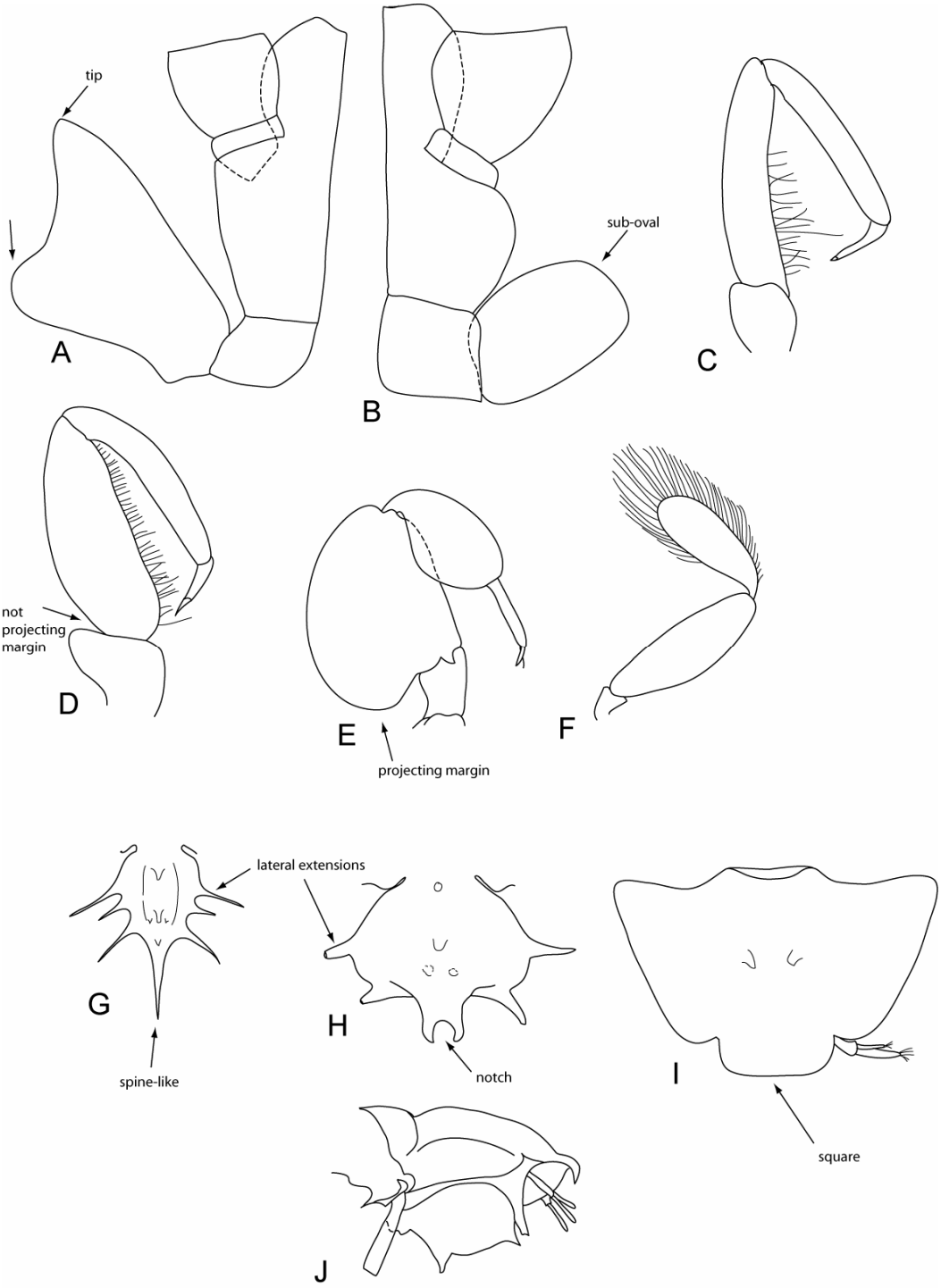

tip
A
sub-oval
B
C
not
projecting
margin
D
E
projecting margin
F
lateral extensions
G
spine-like
H
notch
I
square
J

Figure 2.6 A, *Storthyngurella menziesi* Malyutina, 1999b, male pleopod 1, after Malyutina 1999b; B, *Pseudomunnopsis beddardi*, male pleopods 2, modified after Hansen 1916; C, *Vanhoeffenura moskalevi* Malyutina 2003a, modified after Malyutina 2003b; D, *Bathybadistes andrewsi*, uropod, modified.

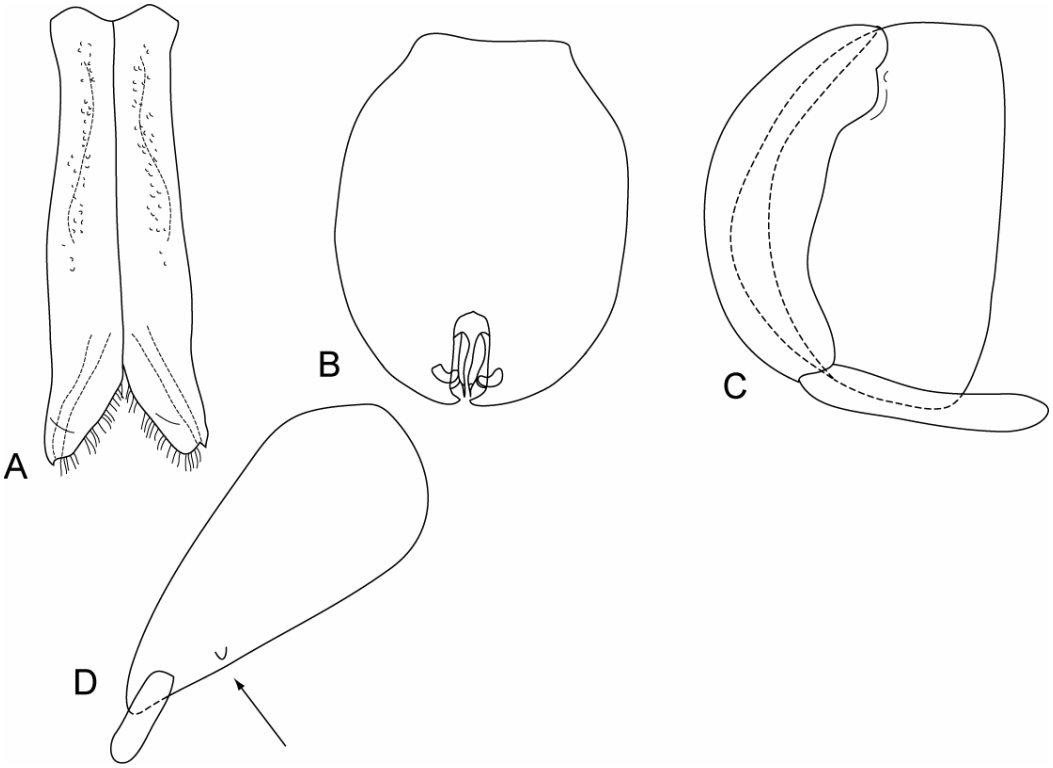

A
B
C
D

Figure 2.7 Analysis 1. Strict consensus tree of 2000 most parsimonious trees found from the unweighted analysis of the full dataset. Numbers above the line refer to bootstrap value for that node, only values 50 and above are mentioned. Numbers below the line refer to clades discussed in the text and Table 2.3.

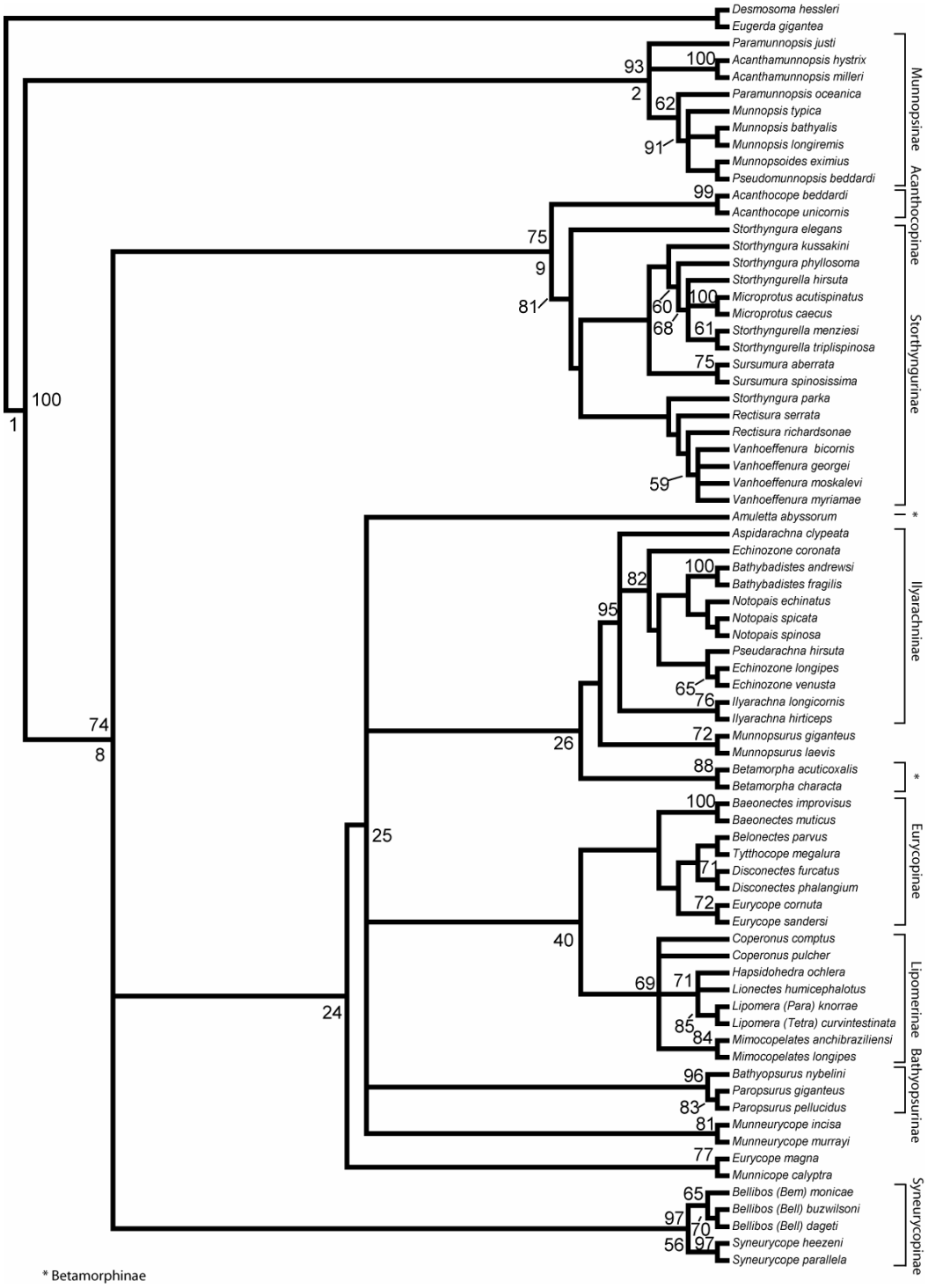

Desmosoma hessleri
Eugerda gigantea
Paramunnopsis justi
Acanthamunnopsis hystrix
Acanthamunnopsis milleri
Paramunnopsis oceanica
Munnopsis typica
Munnopsis bathyalis
Munnopsis longiremis
Munnopsoides eximius
Pseudomunnopsis beddardi
Acanthocope beddardi
Acanthocope unicornis
Storthyngura elegans
Storthyngura kussakini
Storthyngura phyllosoma
Storthyngurella hirsuta
Microprotus acutispinatus
Microprotus caecus
Storthyngurella menziesi
Storthyngurella triplispinosa
Sursumura aberrata
Sursumura spinosissima
Storthyngura parka
Rectisura serrata
Rectisura richardsonae
Vanhoeffenura bicornis
Vanhoeffenura georgei
Vanhoeffenura moskalevi
Vanhoeffenura myriamae
Amuletta abyssorum
Aspidarachna clypeata
Echinozone coronata
Bathybadistes andrewsi
Bathybadistes fragilis
Notopais echinatus
Notopais spicata
Notopais spinosa
Pseudarachna hirsuta
Echinozone longipes
Echinozone venusta
Ilyarachna longicornis
Ilyarachna hirticeps
Munnopsurus giganteus
Munnopsurus laevis
Betamorpha acuticoxalis
Betamorpha characta
Baeonectes improvisus
Baeonectes muticus
Belonectes parvus
Tytthocope megalura
Disconectes furcatus
Disconectes phalangium
Eurycope cornuta
Eurycope sandersi
Coperonus comptus
Coperonus pulcher
Hapsidohedra ochlera
Lionectes humicephalotus
Lipomera (Para) knorrae
Lipomera (Tetra) curvintestinata
Mimocopelates anchibraziliensi
Mimocopelates longipes
Bathyopsurus nybelini
Paropsurus giganteus
Paropsurus pellucidus
Munneurycope incisa
Munneurycope murrayi
Eurycope magna
Munnicope calyptra
Bellibos (Bem) monicae
Bellibos (Bell) buzwilsoni
Bellibos (Bell) dageti
Syneurycope heezeni
Syneurycope parallela
Munnopsinae
Acanthocopinae
Storthyngurinae
Ilyarachninae
Eurycopinae
Lipomerinae
Bathyopsurinae
Syneurycopinae
* Betamorphinae

Figure 2.8 Analysis 2. Strict consensus tree of nine most parsimonious trees found from the successively weighted analysis of the full dataset. Numbers above the line refer to bootstrap value for that node, only values 50 and above are mentioned. Numbers and letters below the line refer to clades discussed in the text and Table 2.3.

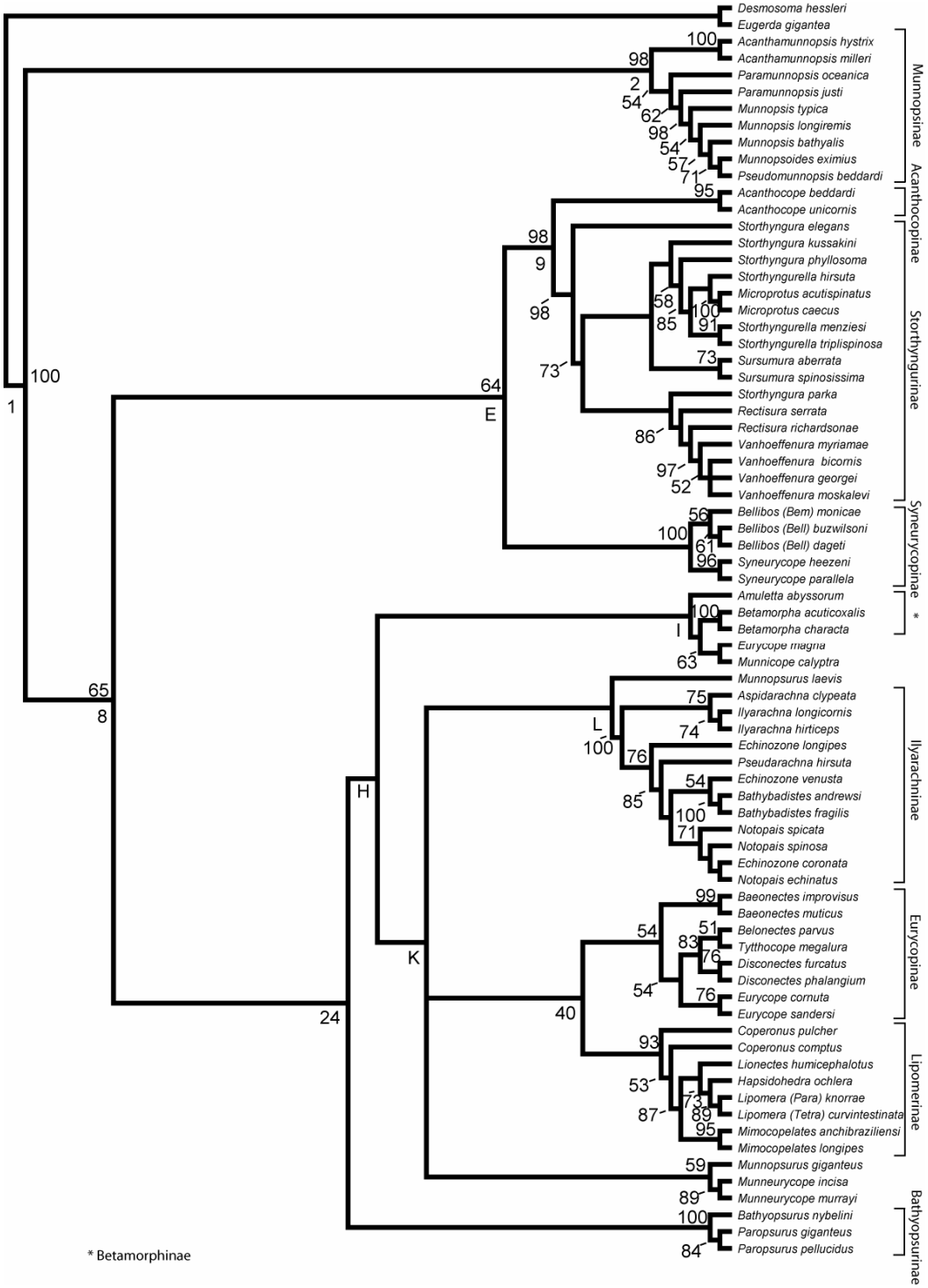
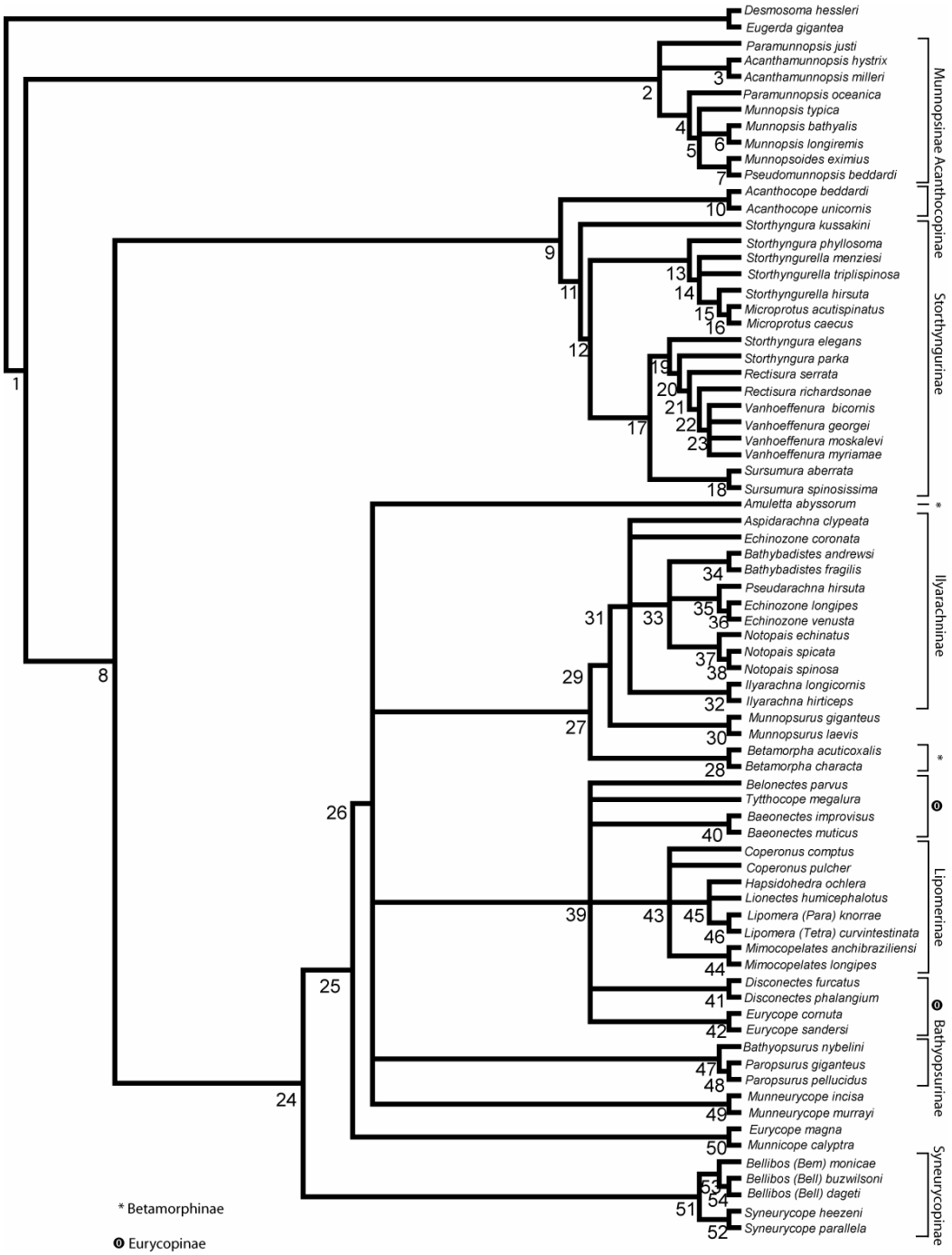

Desmosoma hessleri
Eugerda gigantea
Acanthamunnopsis hystrix
Acanthamunnopsis milleri
Paramunnopsis oceanica
Paramunnopsis justi
Munnopsis typica
Munnopsis longiremis
Munnopsis bathyalis
Munnopsoides eximius
Pseudomunnopsis beddardi
Acanthocope beddardi
Acanthocope unicornis
Storthyngura elegans
Storthyngura kussakini
Storthyngura phyllosoma
Storthyngurella hirsuta
Microprotus acutispinatus
Microprotus caecus
Storthyngurella menziesi
Storthyngurella triplispinosa
Sursumura aberrata
Sursumura spinosissima
Storthyngura parka
Rectisura serrata
Rectisura richardsonae
Vanhoeffenura myriamae
Vanhoeffenura bicornis
Vanhoeffenura georgei
Vanhoeffenura moskalevi
Bellibos (Bem) monicae
Bellibos (Bell) buzwilsoni
Bellibos (Bell) dageti
Syneurycope heezeni
Syneurycope parallela
Amuletta abyssorum
Betamorpha acuticoxalis
Betamorpha characta
Eurycope magna
Munnicope calyptra
Munnopsurus laevis
Aspidarachna clypeata
Ilyarachna longicornis
Ilyarachna hirticeps
Echinozone longipes
Pseudarachna hirsuta
Echinozone venusta
Bathybadistes andrewsi
Bathybadistes fragilis
Notopais spicata
Notopais spinosa
Echinozone coronata
Notopais echinatus
Baeonectes improvisus
Baeonectes muticus
Belonectes parvus
Tytthocope megalura
Disconectes furcatus
Disconectes phalangium
Eurycope cornuta
Eurycope sandersi
Coperonus pulcher
Coperonus comptus
Lionectes humicephalotus
Hapsidohedra ochlera
Lipomera (Para) knorrae
Lipomera (Tetra) curvintestinata
Mimocopelates anchibraziliensi
Mimocopelates longipes
Munnopsurus giganteus
Munneurycope incisa
Munneurycope murrayi
Bathyopsurus nybelini
Paropsurus giganteus
Paropsurus pellucidus
Munnopsinae
Acanthocopinae
Storthyngurinae
Syneurycopinae
*
Ilyarachninae
Eurycopinae
Lipomerinae
Bathyopsurinae
* Betamorphinae

Figure 2.9 Analysis 3. Strict consensus tree of 755 most parsimonious trees found from the unweighted analysis of the modified dataset. Numbers below the line refer to clades discussed in the text and Table 2.4.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Eugerda gigantea
Paramunnopsis justi
Acanthamunnopsis hystrix
Acanthamunnopsis milleri
Paramunnopsis oceanica
Munnopsis typica
Munnopsis bathyalis
Munnopsis longiremis
Munnopsoides eximius
Pseudomunnopsis beddardi
Munnopsinae
Acanthocope beddardi
Acanthocope unicornis
Acanthocopinae
Storthyngura kussakini
Storthyngura phyllosoma
Storthyngurella menziesi
Storthyngurella triplispinosa
Storthyngurella hirsuta
Microprotus acutispinatus
Microprotus caecus
Storthyngura elegans
Storthyngura parka
Rectisura serrata
Rectisura richardsonae
Vanhoeffenura bicornis
Vanhoeffenura georgei
Vanhoeffenura moskalevi
Vanhoeffenura myriamae
Sursumura aberrata
Sursumura spinosissima
Storthyngurinae
Amuletta abyssorum
*
Aspidarachna clypeata
Echinozone coronata
Bathybadistes andrewsi
Bathybadistes fragilis
Pseudarachna hirsuta
Echinozone longipes
Echinozone venusta
Notopais echinatus
Notopais spicata
Notopais spinosa
Ilyarachna longicornis
Ilyarachna hirticeps
Ilyarachninae
Munnopsurus giganteus
Munnopsurus laevis
Betamorpha acuticoxalis
Betamorpha characta
*
Belonectes parvus
Tytthocope megalura
Baeonectes improvisus
Baeonectes muticus
Coperonus comptus
Coperonus pulcher
Hapsidohedra ochlera
Lionectes humicephalotus
Lipomera (Para) knorrae
Lipomera (Tetra) curvintestinata
Mimocopelates anchibraziliensi
Mimocopelates longipes
Lipomerinae
Disconectes furcatus
Disconectes phalangium
Eurycope cornuta
Eurycope sandersi
Bathyopsurinae
Bathyopsurus nybelini
Paropsurus giganteus
Paropsurus pellucidus
Munneurycope incisa
Munneurycope murrayi
Eurycope magna
Munnicope calyptra
Bellibos (Bem) monicae
Bellibos (Bell) buzwilsoni
Bellibos (Bell) dageti
Syneurycope heezeni
Syneurycope parallela
Syneurycopinae
1
2
3
4
5
6
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9
10
11
12
13
14
15
16
17
18
19
20
21
22
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36
37
38
39
40
41
42
43
44
45
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49
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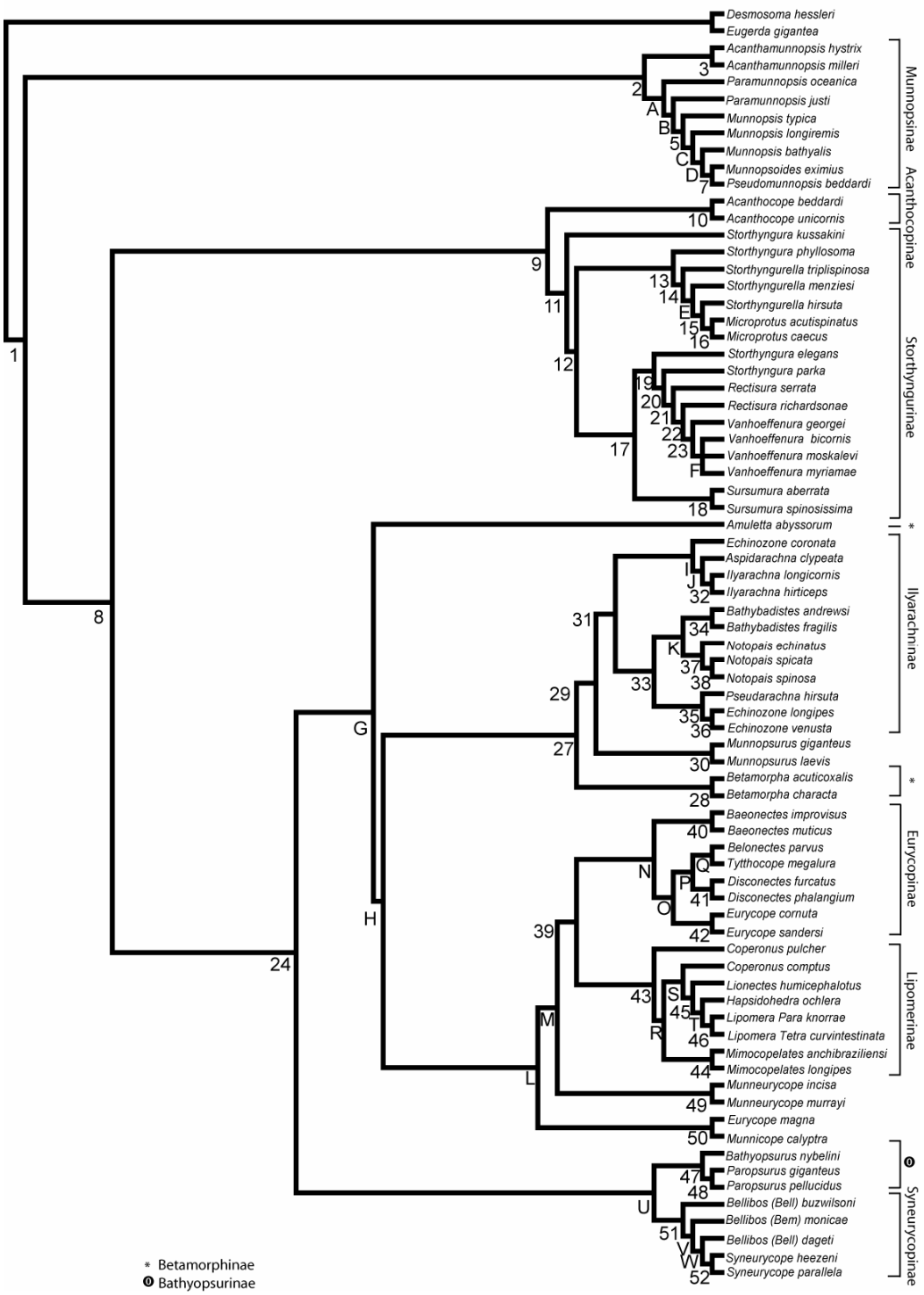
53
54
* Betamorphinae
Eurycopinae

Figure 2.10 Analysis 4. Strict consensus tree of 3 most parsimonious trees found from the successively weighted analysis of the modified dataset. Numbers and letters below the line refer to clades discussed in the text and Table 2.4.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Eugerda gigantea
Acanthamunnopsis hystrix
Acanthamunnopsis milleri
Paramunnopsis oceanica
Paramunnopsis justi
Munnopsis typica
Munnopsis longiremis
Munnopsis bathyalis
Munnopsoides eximius
Pseudomunnopsis beddardi
Munnopsinae
Acanthocope beddardi
Acanthocope unicornis
Acanthocopinae
Storthyngura kussakini
Storthyngura phyllosoma
Storthyngurella triplispinosa
Storthyngurella menziesi
Storthyngurella hirsuta
Microprotus acutispinatus
Microprotus caecus
Storthyngura elegans
Storthyngura parka
Rectisura serrata
Rectisura richardsonae
Vanhoeffenura georgei
Vanhoeffenura bicornis
Vanhoeffenura moskalevi
Vanhoeffenura myriamae
Sursumura aberrata
Sursumura spinosissima
Storthyngurinae
Amuletta abyssorum
*
Echinozone coronata
Aspidarachna clypeata
Ilyarachna longicornis
Ilyarachna hirticeps
Bathybadistes andrewsi
Bathybadistes fragilis
Notopais echinatus
Notopais spicata
Notopais spinosa
Pseudarachna hirsuta
Echinozone longipes
Echinozone venusta
Ilyarachninae
Munnopsurus giganteus
Munnopsurus laevis
Betamorpha acuticoxalis
Betamorpha characta
*
Baeonectes improvisus
Baeonectes muticus
Belonectes parvus
Tytthocope megalura
Disconectes furcatus
Disconectes phalangium
Eurycope cornuta
Eurycope sandersi
Eurycopinae
Coperonus pulcher
Coperonus comptus
Lionectes humicephalotus
Hapsidohedra ochlera
Lipomera Para knorrae
Lipomera Tetra curvintestinata
Mimocopelates anchibraziliensi
Mimocopelates longipes
Lipomerinae
Munneurycope incisa
Munneurycope murrayi
Eurycope magna
Munnicope calyptra
Bathyopsurus nybelini
Paropsurus giganteus
Paropsurus pellucidus
Bellibos (Bell) buzwilsoni
Bellibos (Bem) monicae
Bellibos (Bell) dageti
Syneurycope heezeni
Syneurycope parallela
Syneurycopinae
1
2
3
A
B
5
C
D
7
9
10
11
12
13
14
E
15
16
17
19
20
21
22
23
F
18
8
31
32
I
J
34
K
37
38
33
29
35
36
27
30
28
G
H
24
39
40
N
Q
P
41
O
42
43
S
45
T
46
R
44
M
L
49
50
47
48
U
51
V
W
52
* Betamorphinae
Bathyopsurinae

Figure 2.11 Clade 2, from the strict consensus trees of analyses 1 and 2. Numbers and letters below the line refer to clades discussed in the text and Table 2.3. A, from analysis 1; B, from analysis 2

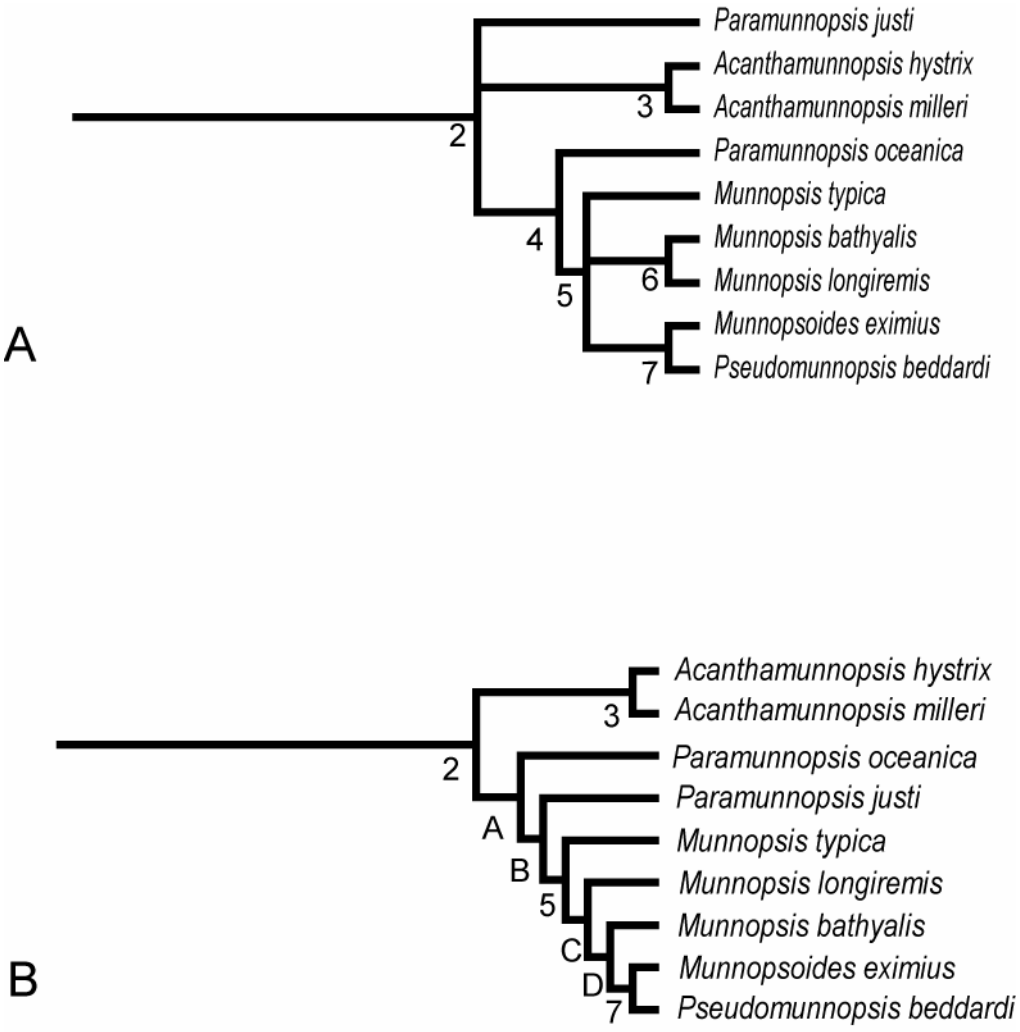

A
Paramunnopsis justi
Acanthamunnopsis hystrix
Acanthamunnopsis milleri
Paramunnopsis oceanica
Munnopsis typica
Munnopsis bathyalis
Munnopsis longiremis
Munnopsoides eximius
Pseudomunnopsis beddardi
2
3
4
5
6
7
B
Acanthamunnopsis hystrix
Acanthamunnopsis milleri
Paramunnopsis oceanica
Paramunnopsis justi
Munnopsis typica
Munnopsis longiremis
Munnopsis bathyalis
Munnopsoides eximius
Pseudomunnopsis beddardi
2
3
A
B
5
C
D
7

Figure 2.12 Clade 9, from the strict consensus trees of analyses 1 and 2. Numbers and letters below the line refer to clades discussed in the text and Table 2.3. A, from analysis 1; B, from analysis 2.

Figures: Chapter 2

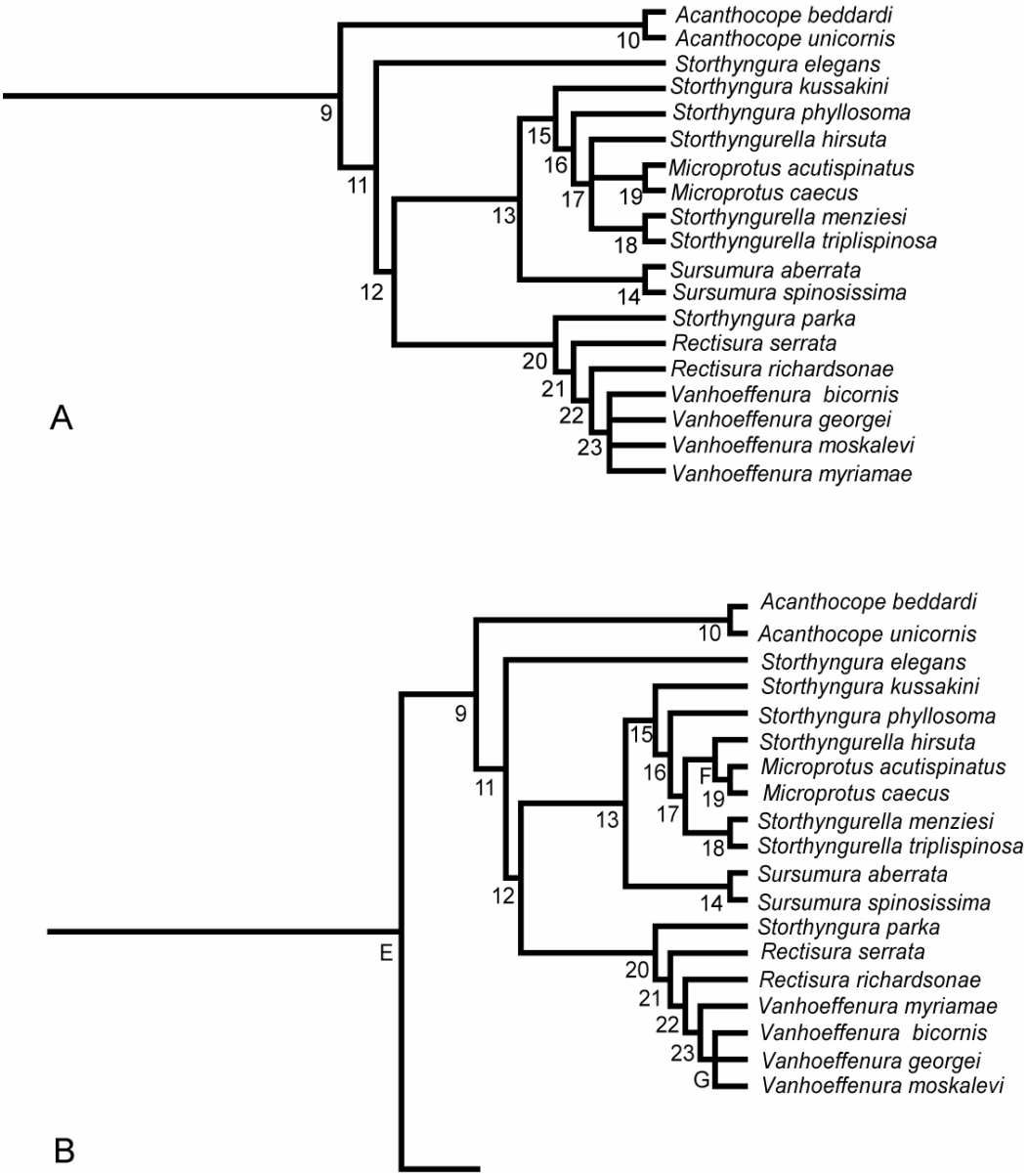
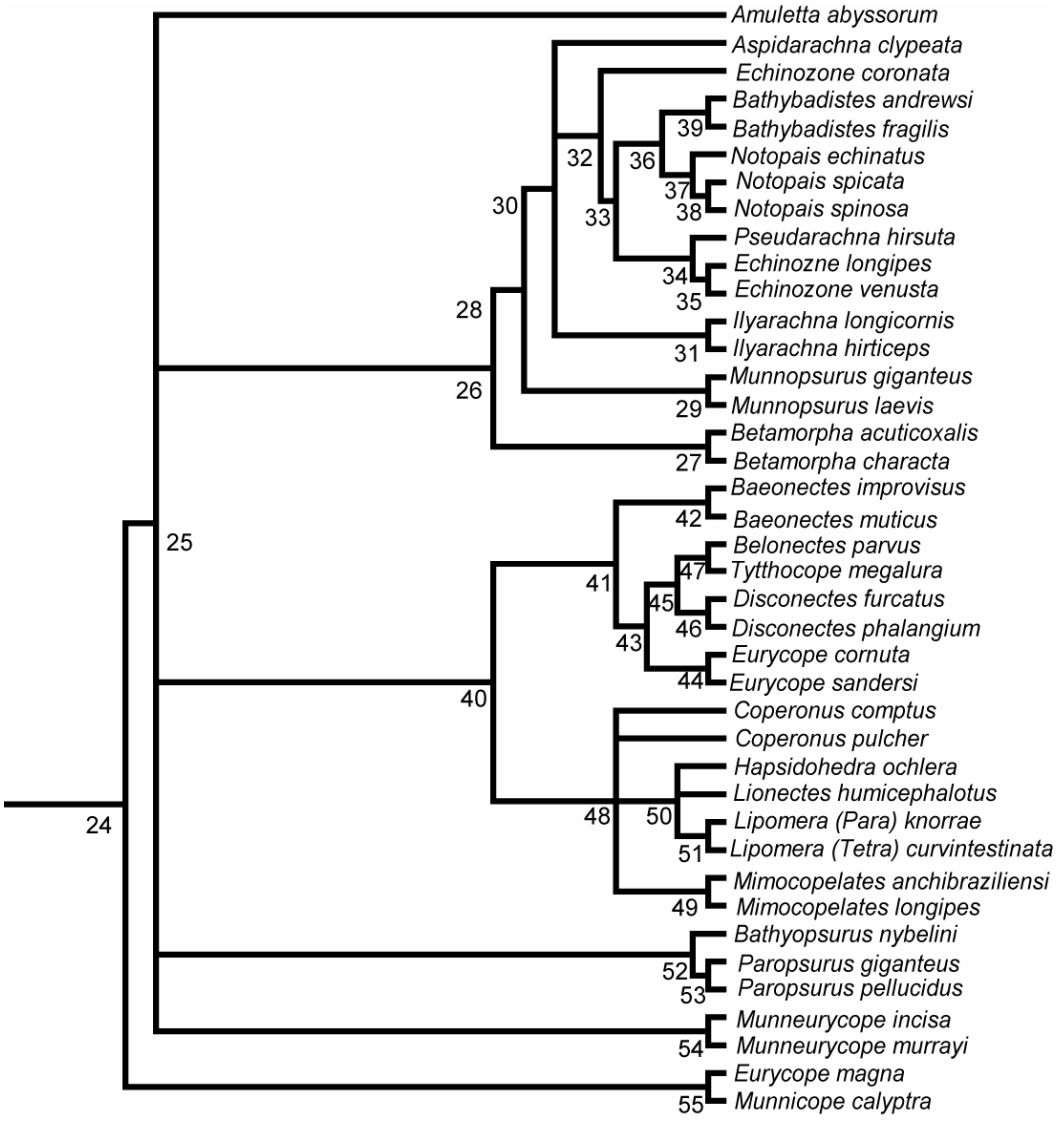


Figure 2.13 Clade 24, from the strict consensus tree of analysis 1. Numbers below the line refer to clades discussed in the text and Table 2.3.


Amuletta abyssorum
Aspidarachna clypeata
Echinozone coronata
Bathybadistes andrewsi
Bathybadistes fragilis
Notopais echinatus
Notopais spicata
Notopais spinosa
Pseudarachna hirsuta
Echinozne longipes
Echinozone venusta
Ilyarachna longicornis
Ilyarachna hirticeps
Munnopsurus giganteus
Munnopsurus laevis
Betamorpha acuticoxalis
Betamorpha characta
Baeonectes improvisus
Baeonectes muticus
Belonectes parvus
Tytthocope megalura
Disconectes furcatus
Disconectes phalangium
Eurycope cornuta
Eurycope sandersi
Coperonus comptus
Coperonus pulcher
Hapsidohedra ochlera
Lionectes humicephalotus
Lipomera (Para) knorrae
Lipomera (Tetra) curvintestinata
Mimocopelates anchibraziliensi
Mimocopelates longipes
Bathyopsurus nybelini
Paropsurus giganteus
Paropsurus pellucidus
Munneurycope incisa
Munneurycope murrayi
Eurycope magna
Munnicope calyptra
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
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54
55

Figure 2.14 Clade 24, from the strict consensus trees of analysis 2. Numbers and letters below the line refer to clades discussed in the text and Table 2.3.

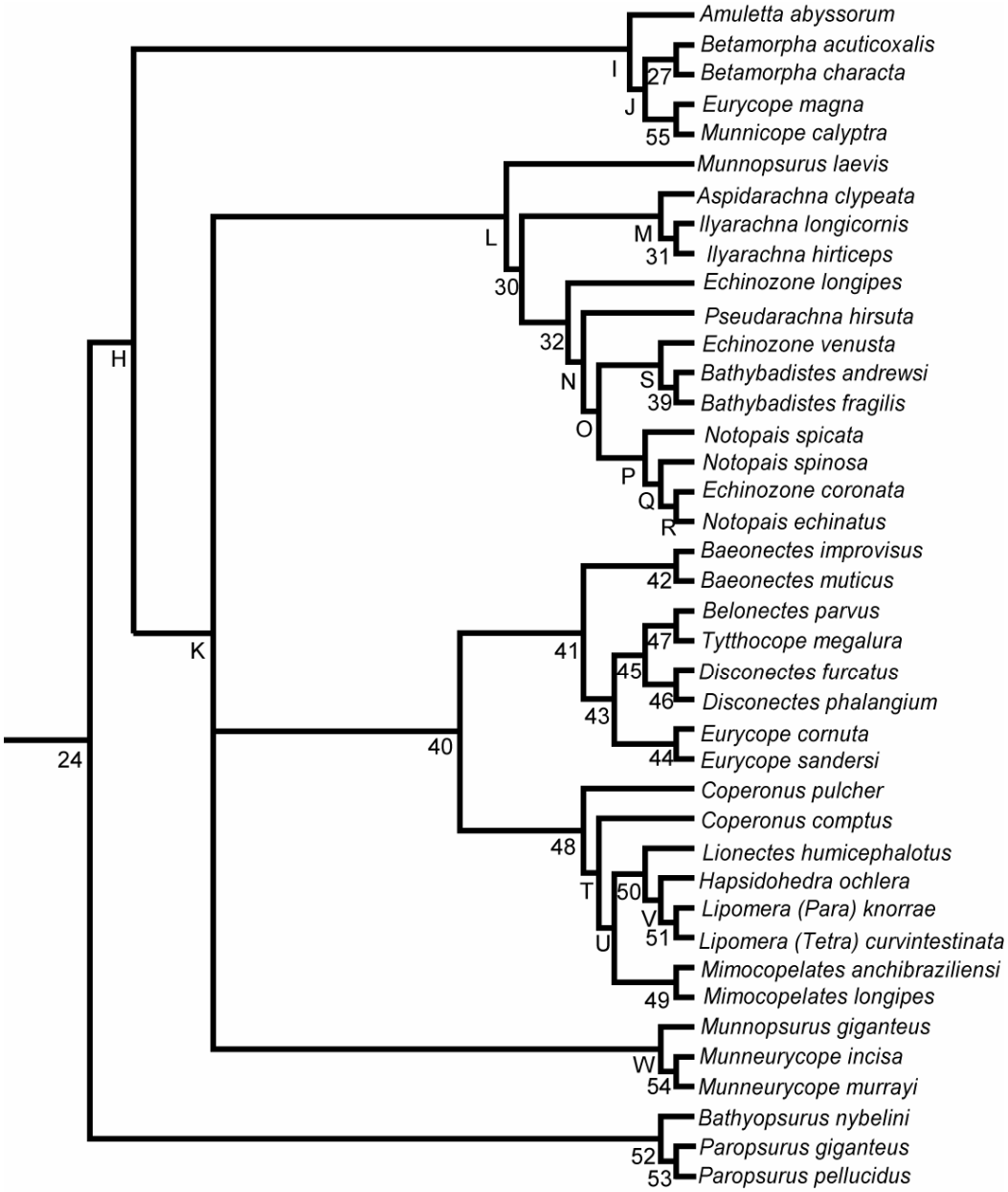
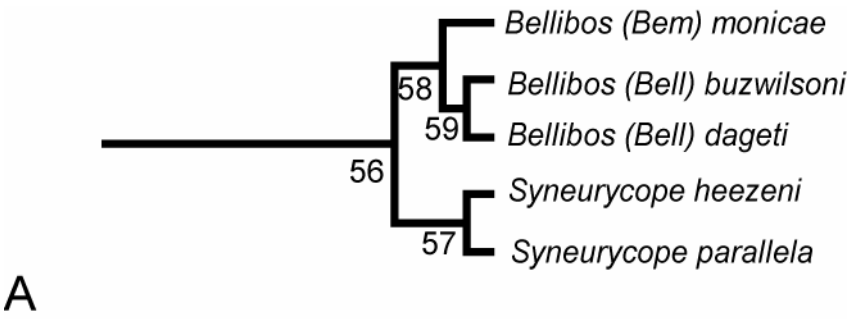
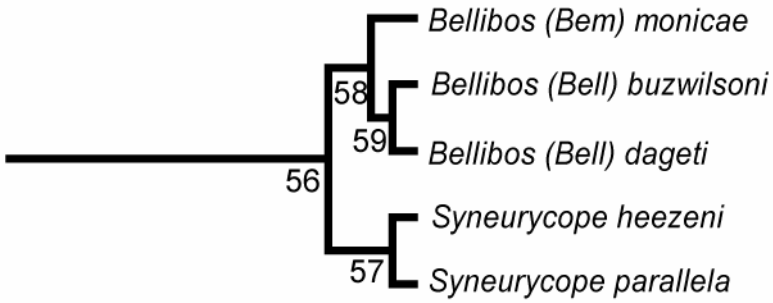

Amuletta abyssorum
Betamorpha acuticoxalis
Betamorpha characta
Eurycope magna
Munnicope calyptra
Munnopsurus laevis
Aspidarachna clypeata
Ilyarachna longicornis
Ilyarachna hirticeps
Echinozone longipes
Pseudarachna hirsuta
Echinozone venusta
Bathybadistes andrewsi
Bathybadistes fragilis
Notopais spicata
Notopais spinosa
Echinozone coronata
Notopais echinatus
Baeonectes improvisus
Baeonectes muticus
Belonectes parvus
Tytthocope megalura
Disconectes furcatus
Disconectes phalangium
Eurycope cornuta
Eurycope sandersi
Coperonus pulcher
Coperonus comptus
Lionectes humicephalotus
Hapsidohedra ochlera
Lipomera (Para) knorrae
Lipomera (Tetra) curvintestinata
Mimocopelates anchibraziliensi
Mimocopelates longipes
Munnopsurus giganteus
Munneurycope incisa
Munneurycope murrayi
Bathyopsurus nybelini
Paropsurus giganteus
Paropsurus pellucidus
I
J
L
M
N
S
O
P
Q
R
H
K
T
V
U
W
24
27
55
30
31
32
39
41
42
47
45
46
43
44
40
48
50
51
49
54
52
53

Figure 2.15 Clade 56, from the strict consensus trees of analyses 1 and 2. Numbers and letters below the line refer to clades discussed in the text and Table 2.3. A, from analysis 1; B, from analysis 2.


Bellibos (Bem) monicae
Bellibos (Bell) buzwilsoni
Bellibos (Bell) dageti
Syneurycope heezeni
Syneurycope parallela
58
59
56
57

A


Bellibos (Bem) monicae
Bellibos (Bell) buzwilsoni
Bellibos (Bell) dageti
Syneurycope heezeni
Syneurycope parallela
58
59
56
57

B

Figure 3.1 A, *Aspidarachna clypeata*, cephalon; B, *Pseudarachna nohinohi* n. sp., cephalon; C, *Echinozone coronata*, cephalon; D, *Notopais euaxos* n. sp., cephalon; E, *Epikopais mystax* n. sp., cephalon; F, *Ilyarachna aculeatus* n. sp., dorsal view of cephalon; G, *Pseudarachna nohinohi* n. sp., dorsal view of cephalon and pereonites 1–3; H, *Aspidarachna clypeata*, dorsal view of cephalon; I, *Echinozone scabra*, dorsal view of pereonites 4–7 and pleotelson, modified after Birstein, 1971; J, *Bathybadistes spinosissima*, dorsal view of pereonites 4–7 and pleotelson, modified after Merrin *et al*. submitted; K, *Ilyarachna aculeatus* n. sp. dorsal view of pereonites 4–7 and pleotelson; L, *Pseudarachna nohinohi* n. sp., antenna 1, articles 1 and 2.

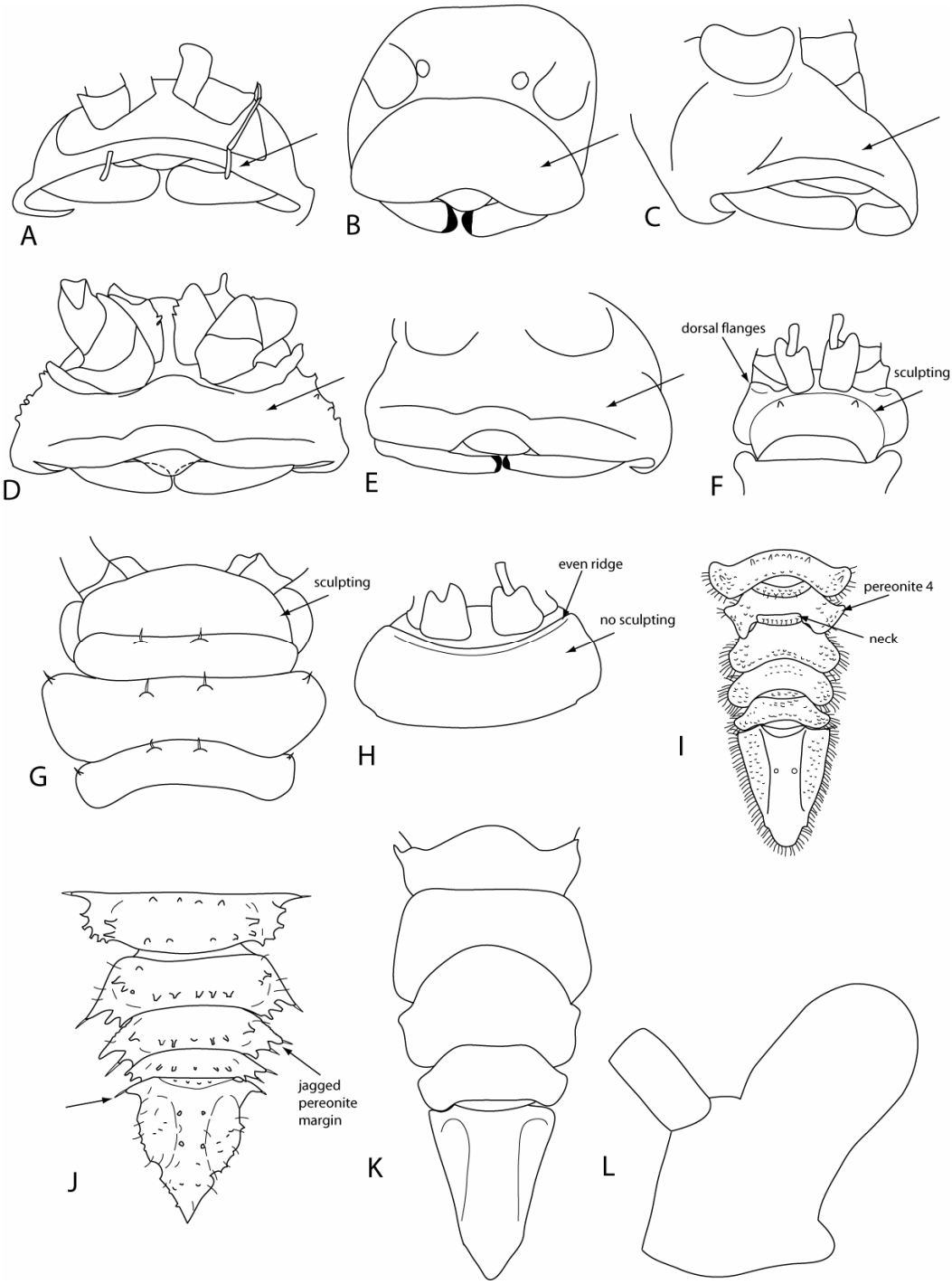

A
B
C
D
E
dorsal flanges
sculpting
F
sculpting
G
even ridge
no sculpting
H
pereonite 4
neck
I
jagged
pereonite
margin
J
K
L

Figure 3.2 A, *Ilyarachna aculeatus* n. sp. antenna 1; B, *Ilyarachna crystallum* n. sp. mandible; C, *Epikopais waringa* n. sp., mandible; D, *Ilyarachna hirticeps*, mandibular palp, after Thistle, 1980; E, *Epikopais waringa* n. sp, operculum; F, Ilyarachna *aculeatus* n. sp. male pleopod 2; G, *Ilyarachna pacifica*, n. sp. male pleopod 2; H, *Pseudarachna nohinohi* n. sp., uropod.

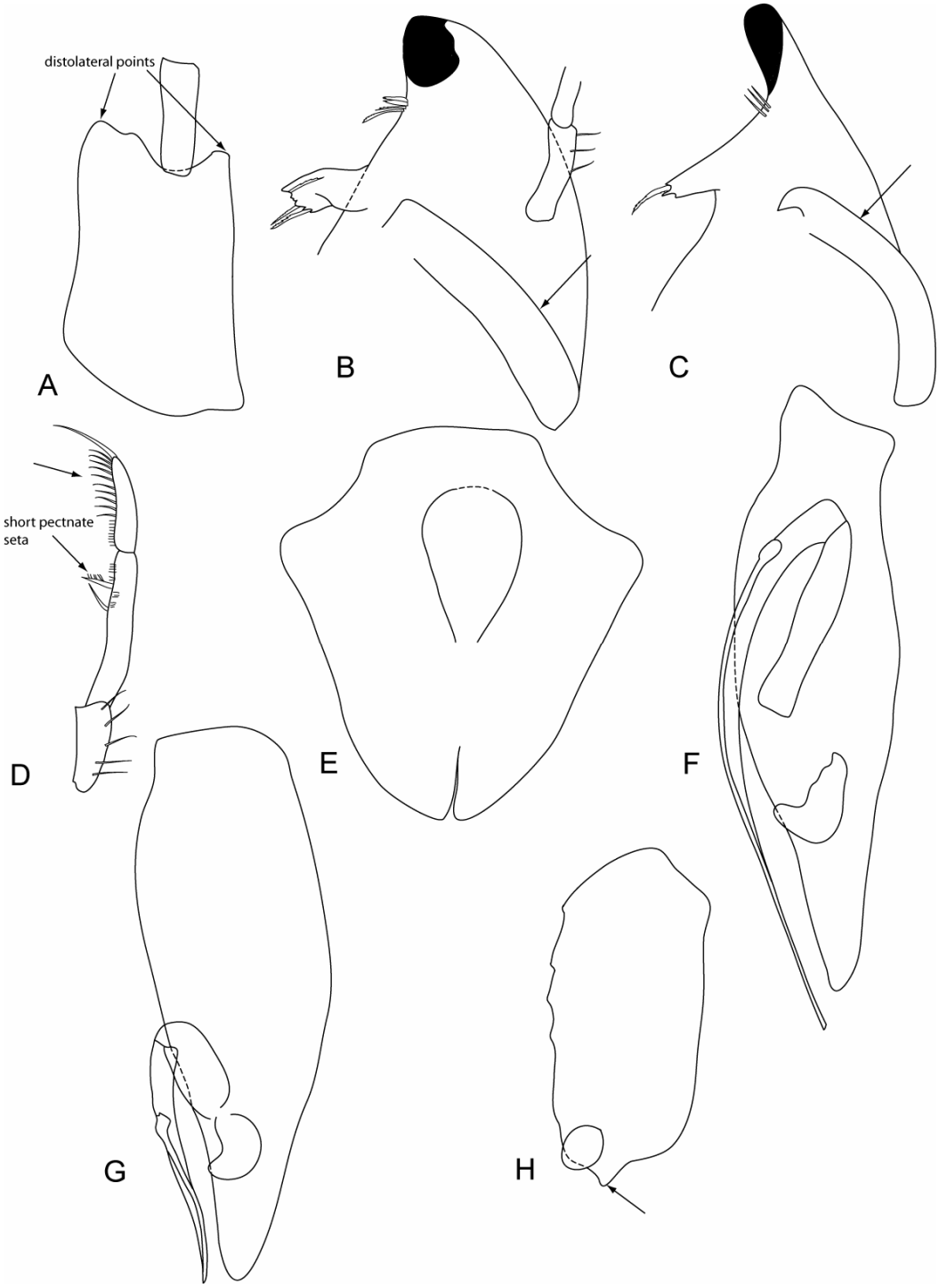

distolateral points
A
B
C
short pectnate seta
D
E
F
G
H

Figure 3.3 Strict consensus tree of 625 most parsimonious trees found from the unweighted analysis.

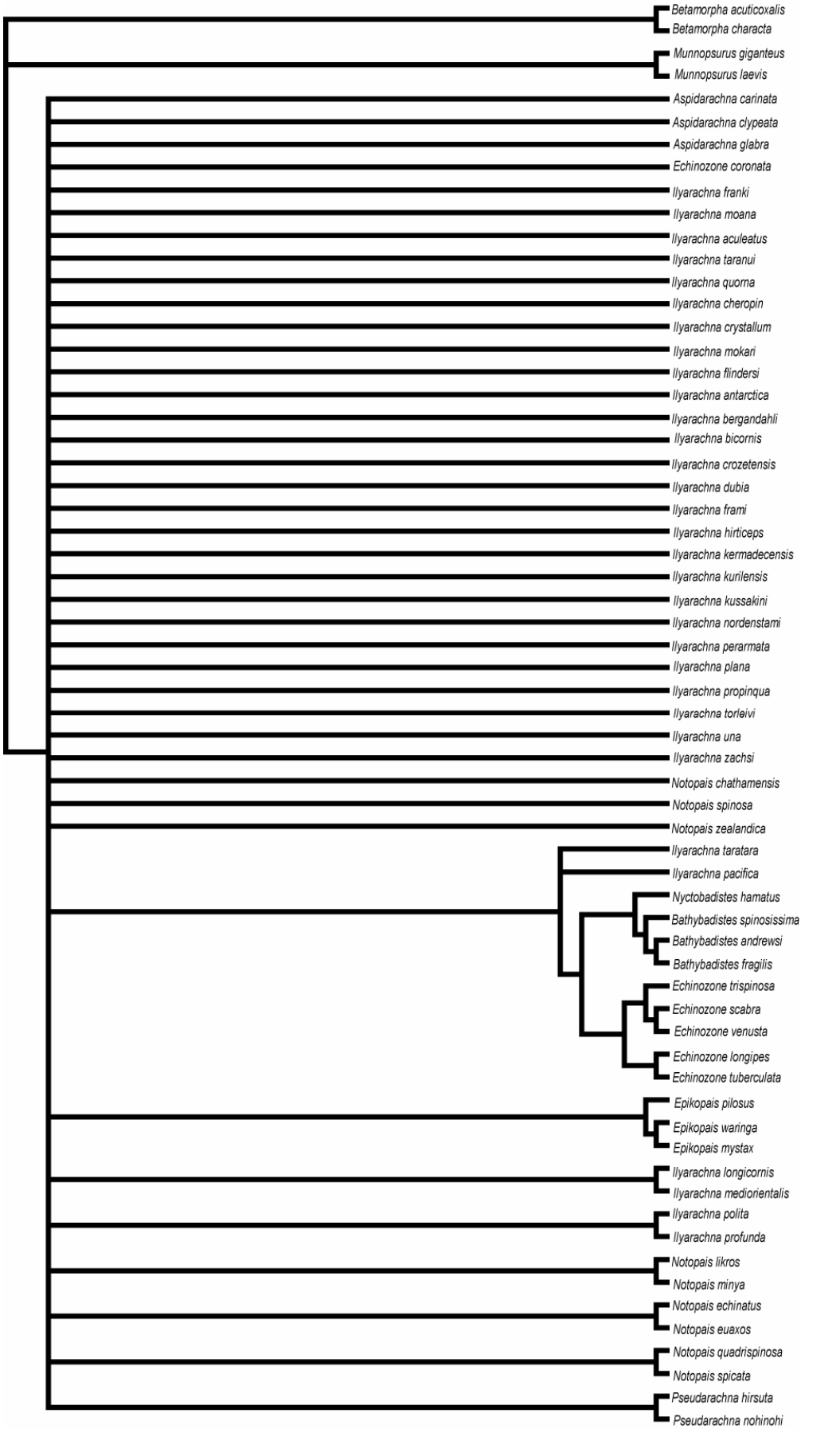

Betamorpha acuticoxalis
Betamorpha characta
Munnopsurus giganteus
Munnopsurus laevis
Aspidarachna carinata
Aspidarachna clypeata
Aspidarachna glabra
Echinozone coronata
Ilyarachna franki
Ilyarachna moana
Ilyarachna aculeatus
Ilyarachna taranui
Ilyarachna quorna
Ilyarachna cheropin
Ilyarachna crystallum
Ilyarachna mokari
Ilyarachna flindersi
Ilyarachna antarctica
Ilyarachna bergandahli
Ilyarachna bicornis
Ilyarachna crozetensis
Ilyarachna dubia
Ilyarachna frami
Ilyarachna hirticeps
Ilyarachna kermadecensis
Ilyarachna kurilensis
Ilyarachna kussakini
Ilyarachna nordenstami
Ilyarachna perarmata
Ilyarachna plana
Ilyarachna propinqua
Ilyarachna torleivi
Ilyarachna una
Ilyarachna zachsi
Notopais chathamensis
Notopais spinosa
Notopais zealandica
Ilyarachna taratara
Ilyarachna pacifica
Nyctobadistes hamatus
Bathybadistes spinosissima
Bathybadistes andrewsi
Bathybadistes fragilis
Echinozone trispinosa
Echinozone scabra
Echinozone venusta
Echinozone longipes
Echinozone tuberculata
Epikopais pilosus
Epikopais waringa
Epikopais mystax
Ilyarachna longicornis
Ilyarachna mediorientalis
Ilyarachna polita
Ilyarachna profunda
Notopais likros
Notopais minya
Notopais echinatus
Notopais euaxos
Notopais quadrispinosa
Notopais spicata
Pseudarachna hirsuta
Pseudarachna nohinohi

Figure 3.4 Strict consensus tree of 2926 most parsimonious trees found from the successively weighted character analysis. Numbers above the line refer to the bootstrap value for that node, only values 50 and above are mentioned. Numbers below the line refer to clades discussed in the text and Table 3.3.

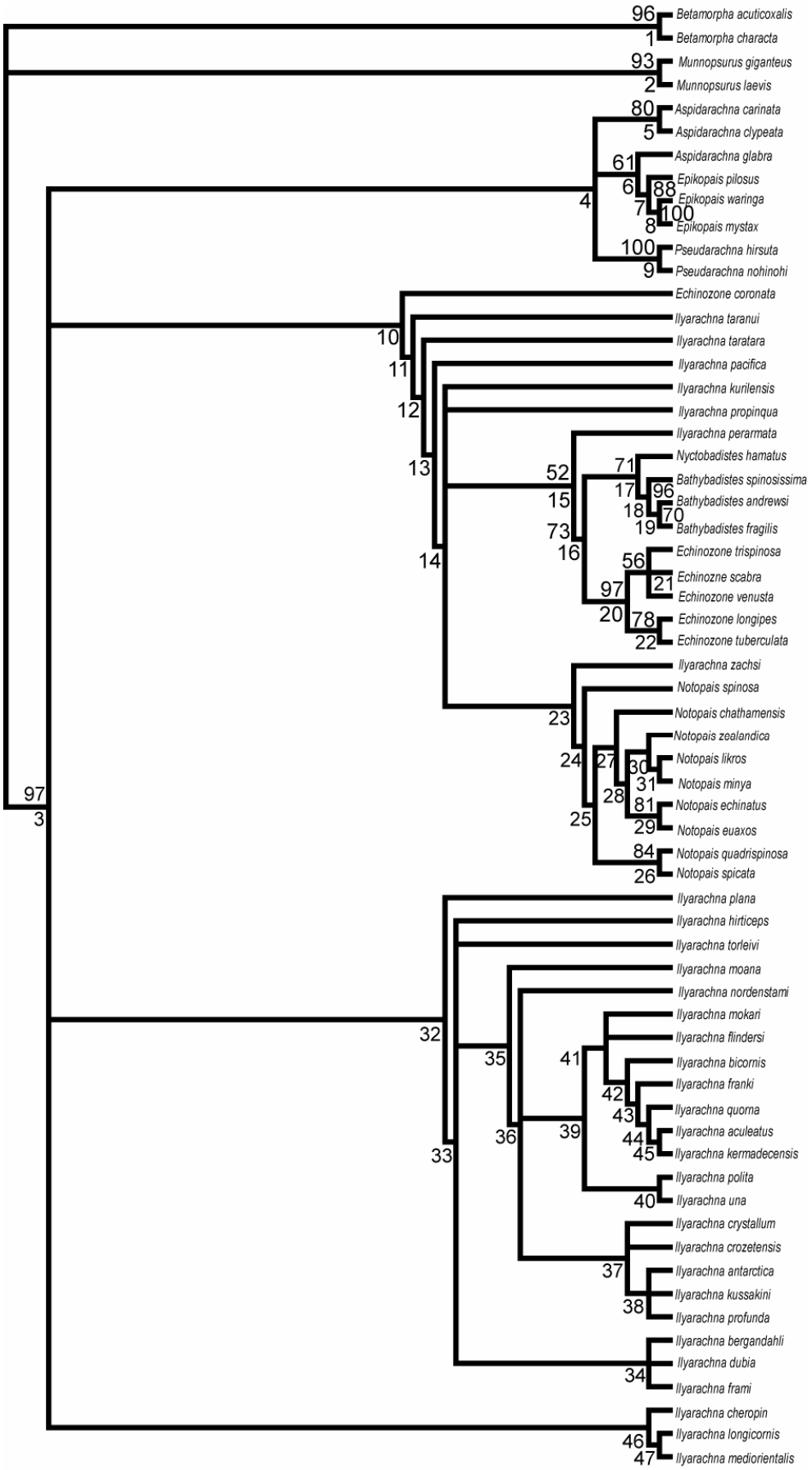

Betamorpha acuticoxalis
Betamorpha characta
Munnopsurus giganteus
Munnopsurus laevis
Aspidarachna carinata
Aspidarachna clypeata
Aspidarachna glabra
Epikopais pilosus
Epikopais waringa
Epikopais mystax
Pseudarachna hirsuta
Pseudarachna nohinohi
Echinozone coronata
Ilyarachna taranui
Ilyarachna taratara
Ilyarachna pacifica
Ilyarachna kurilensis
Ilyarachna propinqua
Ilyarachna perarmata
Nyctobadistes hamatus
Bathybadistes spinosissima
Bathybadistes andrewsi
Bathybadistes fragilis
Echinozone trispinosa
Echinozne scabra
Echinozone venusta
Echinozone longipes
Echinozone tuberculata
Ilyarachna zachsi
Notopais spinosa
Notopais chathamensis
Notopais zealandica
Notopais likros
Notopais minya
Notopais echinatus
Notopais euaxos
Notopais quadrispinosa
Notopais spicata
Ilyarachna plana
Ilyarachna hirticeps
Ilyarachna torleivi
Ilyarachna moana
Ilyarachna nordenstami
Ilyarachna mokari
Ilyarachna flindersi
Ilyarachna bicornis
Ilyarachna franki
Ilyarachna quorna
Ilyarachna aculeatus
Ilyarachna kermadecensis
Ilyarachna polita
Ilyarachna una
Ilyarachna crystallum
Ilyarachna crozetensis
Ilyarachna antarctica
Ilyarachna kussakini
Ilyarachna profunda
Ilyarachna bergandahli
Ilyarachna dubia
Ilyarachna frami
Ilyarachna cheropin
Ilyarachna longicornis
Ilyarachna mediorientalis

Figure 4.1 Station records of *Ilyarachna*-group specimens from around New Zealand and south-eastern Australia examined in this study and collected by the Australian Museum (green circle), Museum Victoria (orange circle) and NIWA (blue circle).

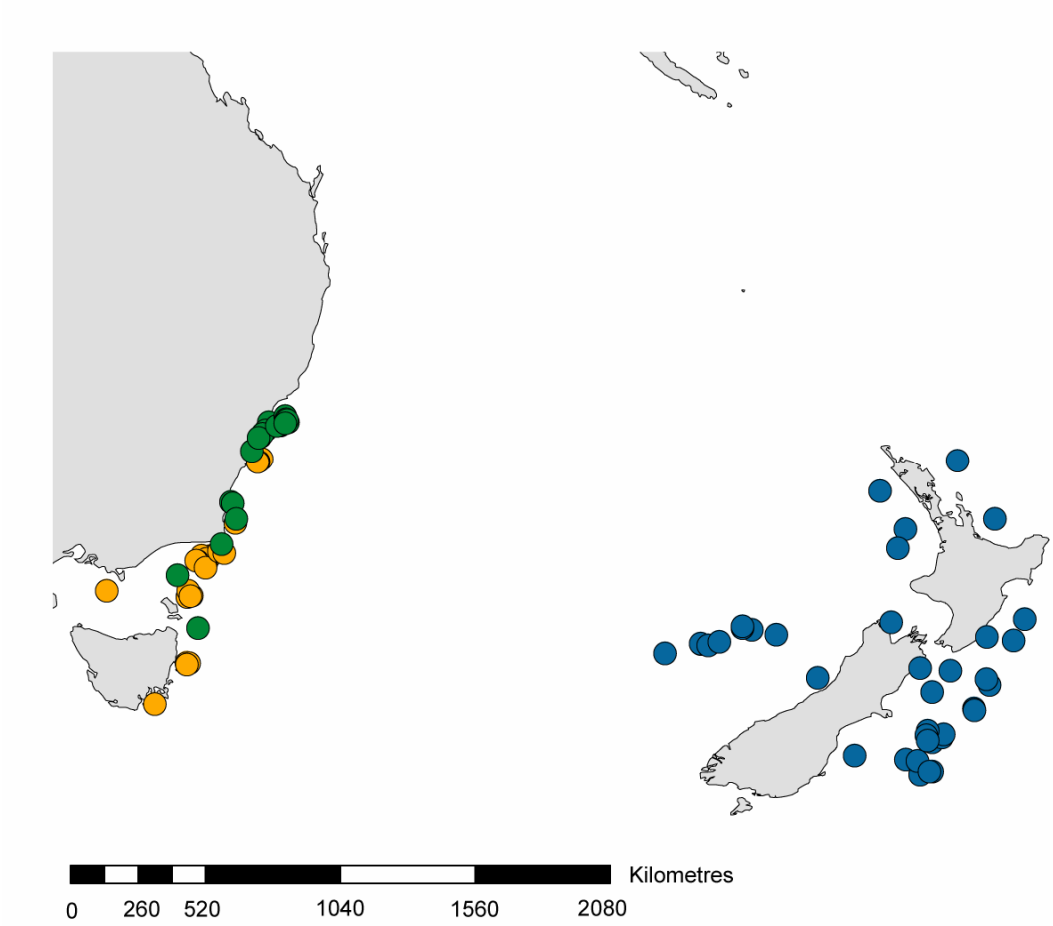

Kilometres
0
260
520
1040
1560
2080

Figure 4.2 *Bathybadistes andrewsi* n. sp., A–D, male holotype, 4.0 mm (NIWA XXXX); E, F, H, I, female paratype 5.0 mm (NIWA XXXX); G, male paratype, 3.5 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, dorsal view of cephalon; E, left antenna 2; F, left antenna 1; G, left antenna 1; H, left maxilla 1; I, left maxilla 2. Scale bar = 1 mm, for dorsal and lateral views only.

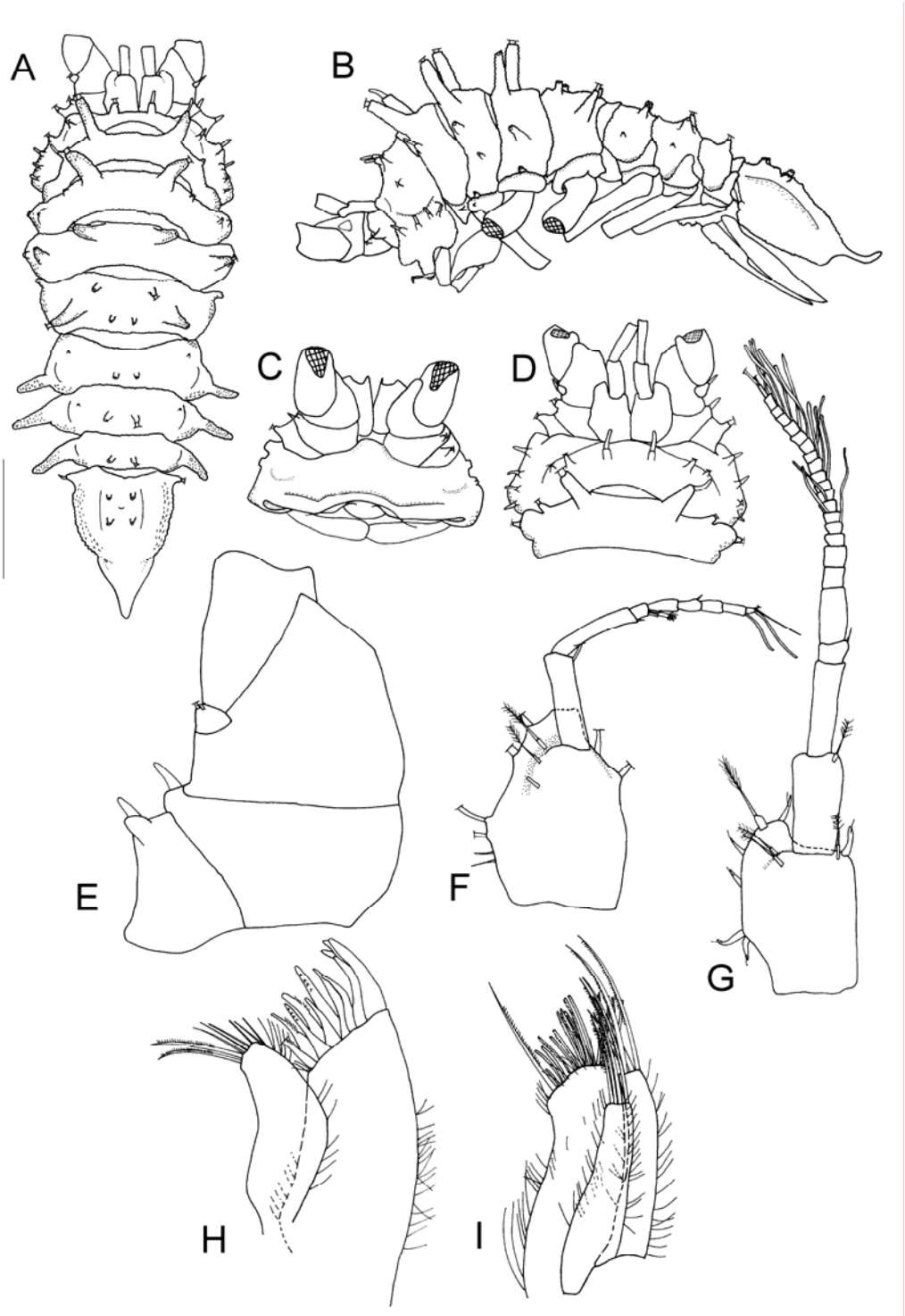

A
B
C
D
E
F
G
H
I

Figure 4.3 *Bathybadistes andrewsi* n. sp. All figures from female paratype, 5.0 mm (NIWA XXXX). A, left mandible; B, right mandible; C, right pereopod 1; D, unguis of right pereopod 1; E, left maxilliped; F, distal part of endite of left maxilliped; G, left pereopod 5.

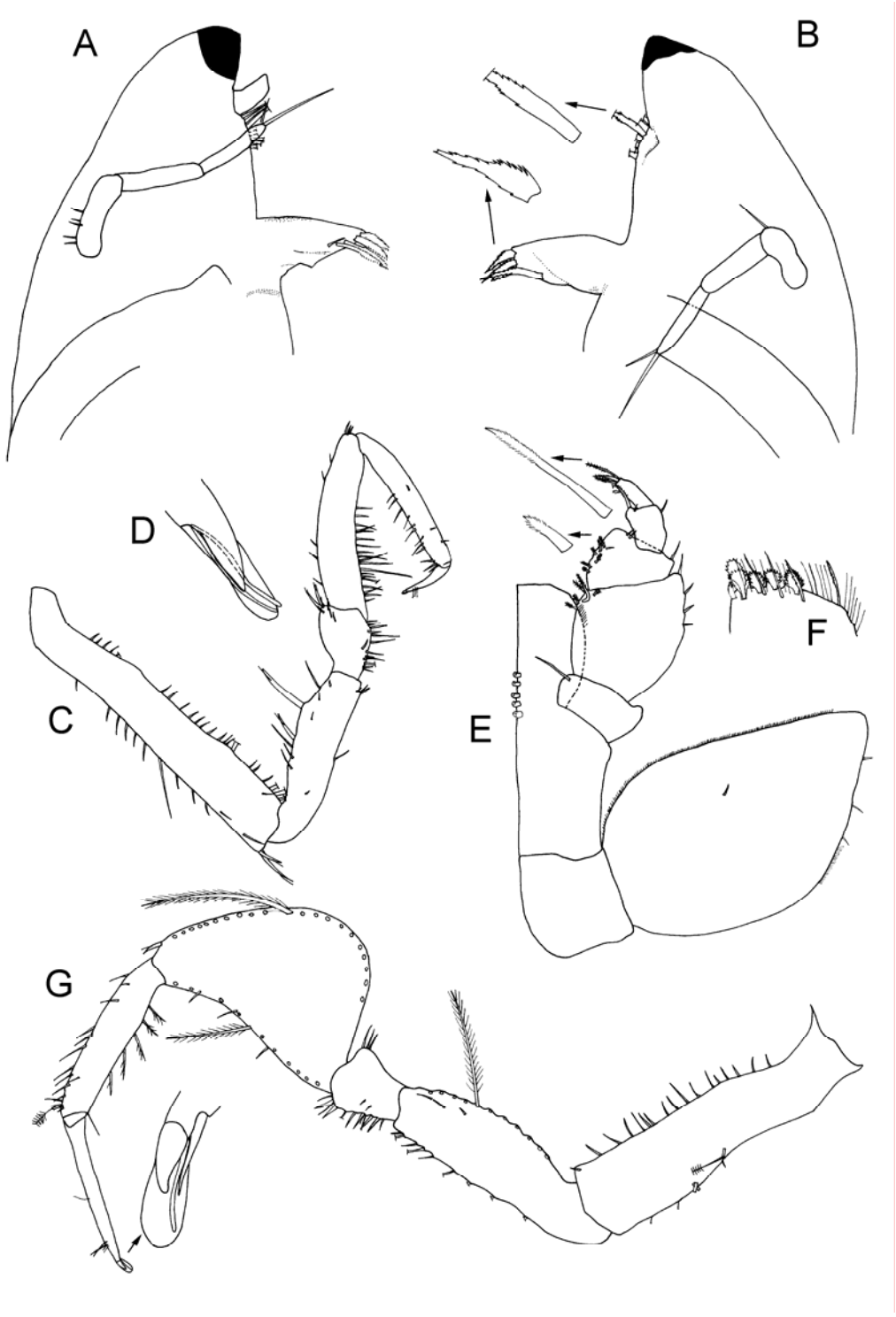

A
B
D
C
E
F
G

Figure 4.4 *Bathybadistes andrewsi* n. sp. A, D–H, female paratype, 5.0 mm (NIWA XXXX); B, C, I, male paratype, 3.5 mm (NIWA XXXX). A, left pereopod 7; B, pleopod 1; C, left pleopod 2; D, operculum; E, right pleopod 3; F, right pleopod 4; G, right pleopod 5; H, right uropod; I, ventral view of pleon and pereonite 7.

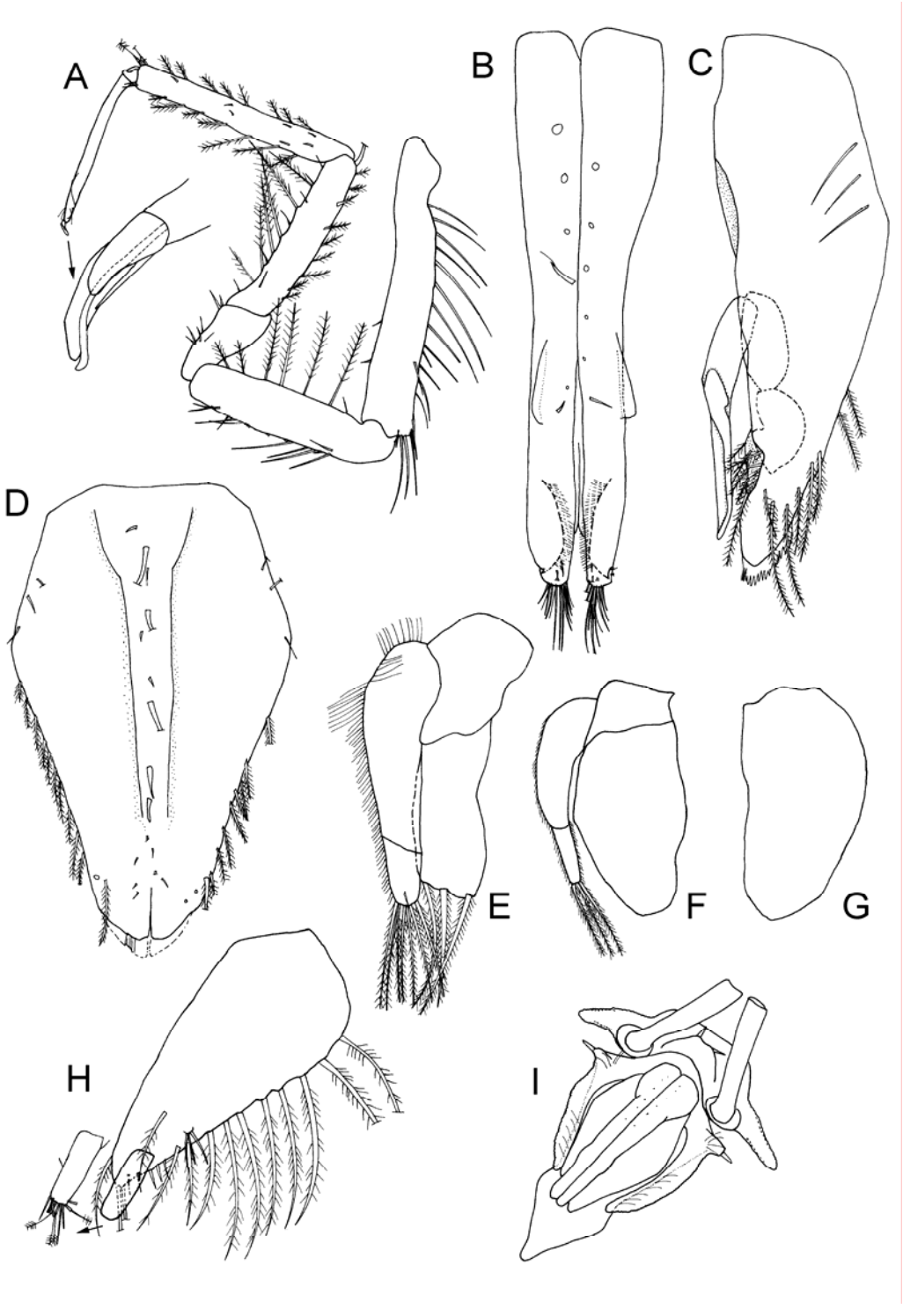

A
B
C
D
E
F
G
H
I

Figure 4.5 *Bathybadistes andrewsi* n. sp. A, E, posterior fragment paratype, 2.0 mm (NIWA XXXX); B, female paratype, 5.0 mm (NIWA XXXX); C, D, anterior fragment paratype, 1mm (NIWA XXXX). A, the operculum *in situ*. The inset is a higher magnification of the medial keel showing the scales, this surface is notably different to the smoother surface either side; B, dorsal spines and setae (which have been affected by the dehydration process) on the anterior pereonites. Notice the difference in scales when comparing the spines to the dorsal surface; C, distally pappose setae on the mesial margin of article 3 of the maxilliped palp; D, a close-up of a distally pappose seta; E, the rudimentary exopod embedded into the uropodal protopod.

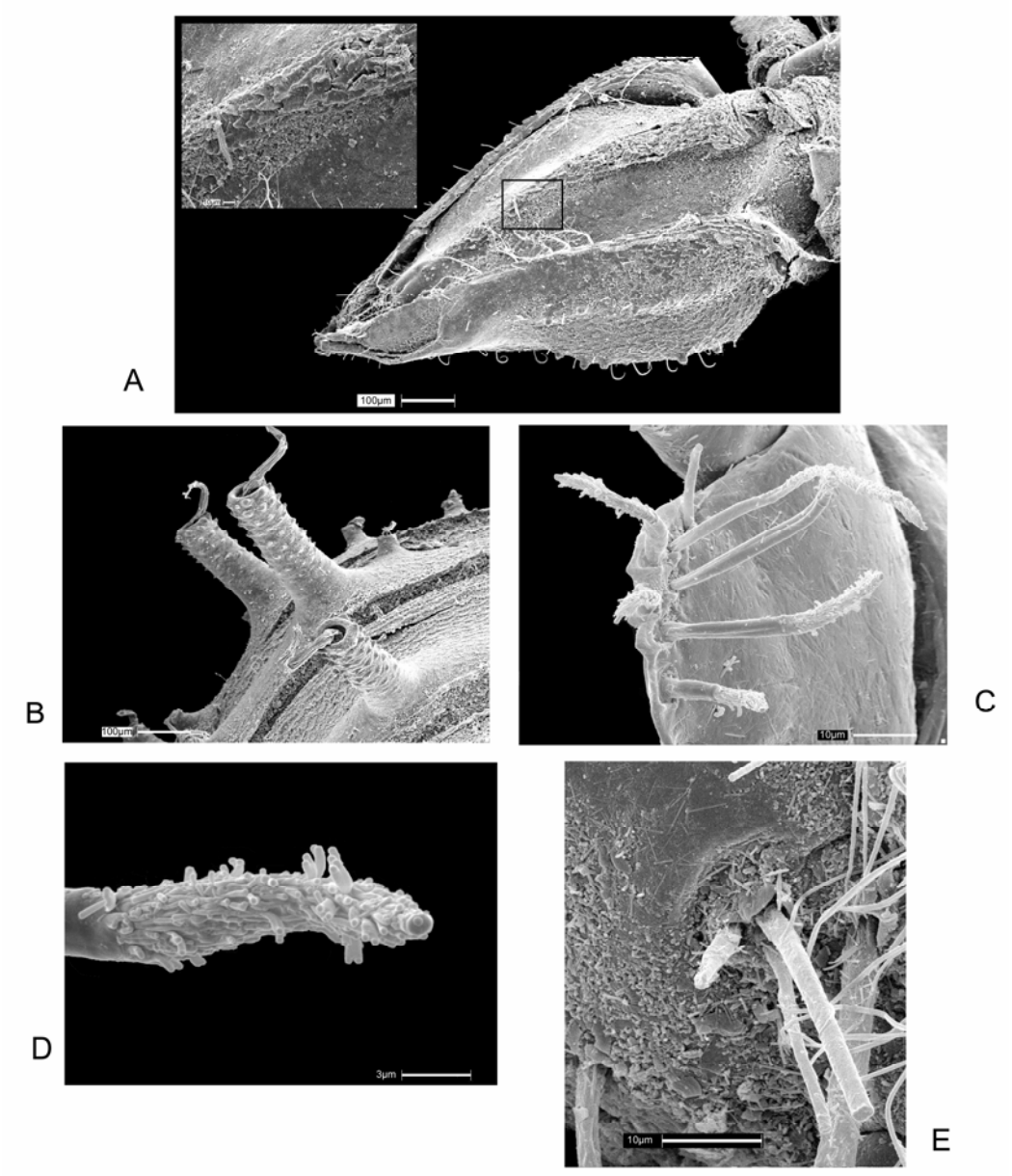

A
100µm
B
100µm
C
10µm
D
3µm
E
10µm

Figure 4.6 *Epikopais mystax* n. sp. A–C, female holotype, 3.0 mm (NIWA XXXX); D–J, female paratype, 2.7 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, right antenna 1; E, right antenna 2; F, left mandible; G, left mandibular molar; H, right mandibular molar; I, right mandible; J, left maxilla 1. Scale bar = 1 mm, for dorsal and lateral views only.

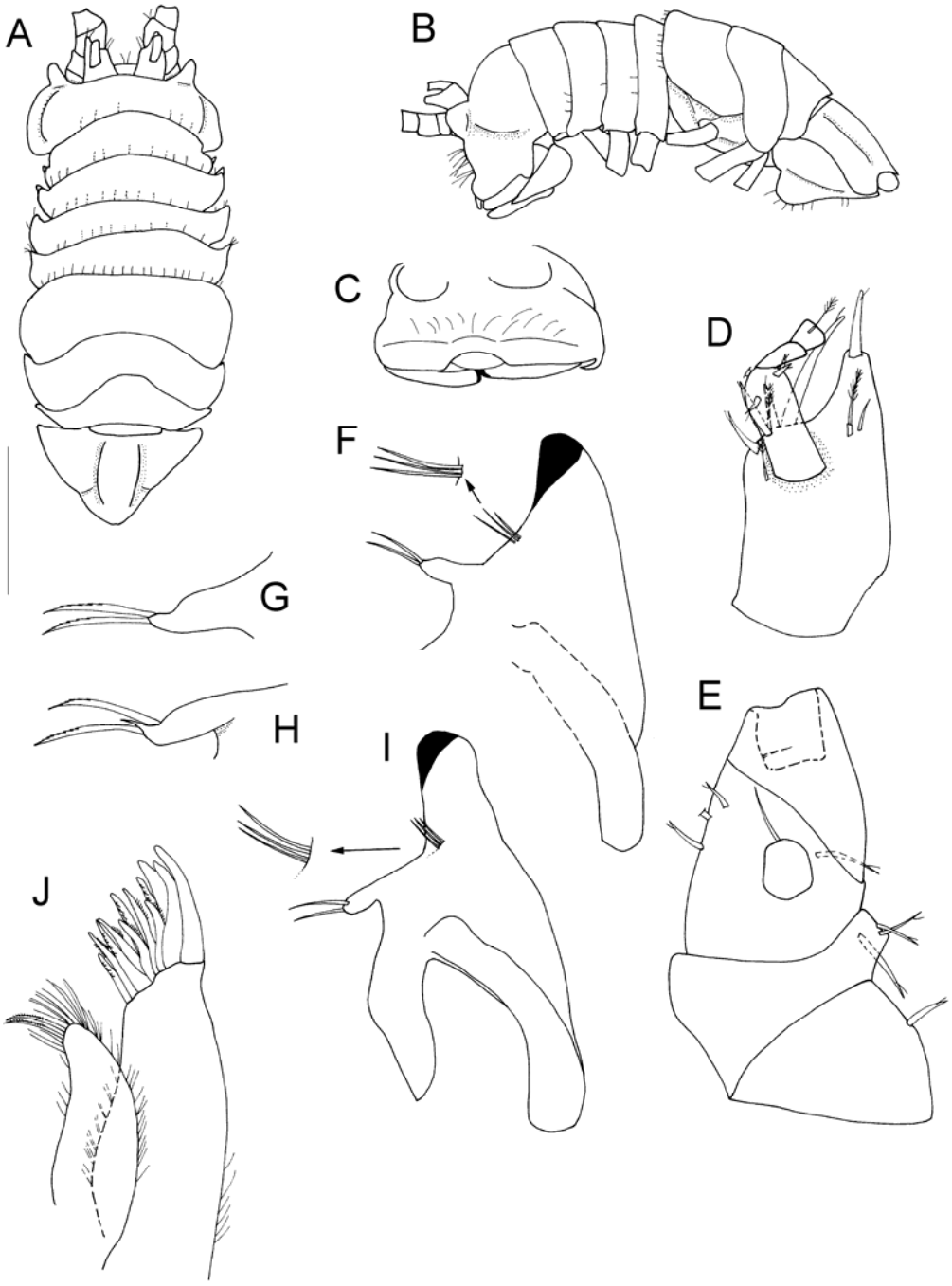

A
B
C
D
F
G
H
I
E
J

Figure 4.7 *Epikopais mystax* n. sp. A–C, E, G, H, female paratype, 2.7 mm (NIWA XXXX); D, F , I, female holotype, 3.0 mm (NIWA XXXX). A, right maxilla 2; B, right maxilliped; C, right maxilliped palp; D, left pereopod 1; E, left pleopod 3; F, operculum; G, right pleopod 4; H, left pleopod 5; I, right uropod.

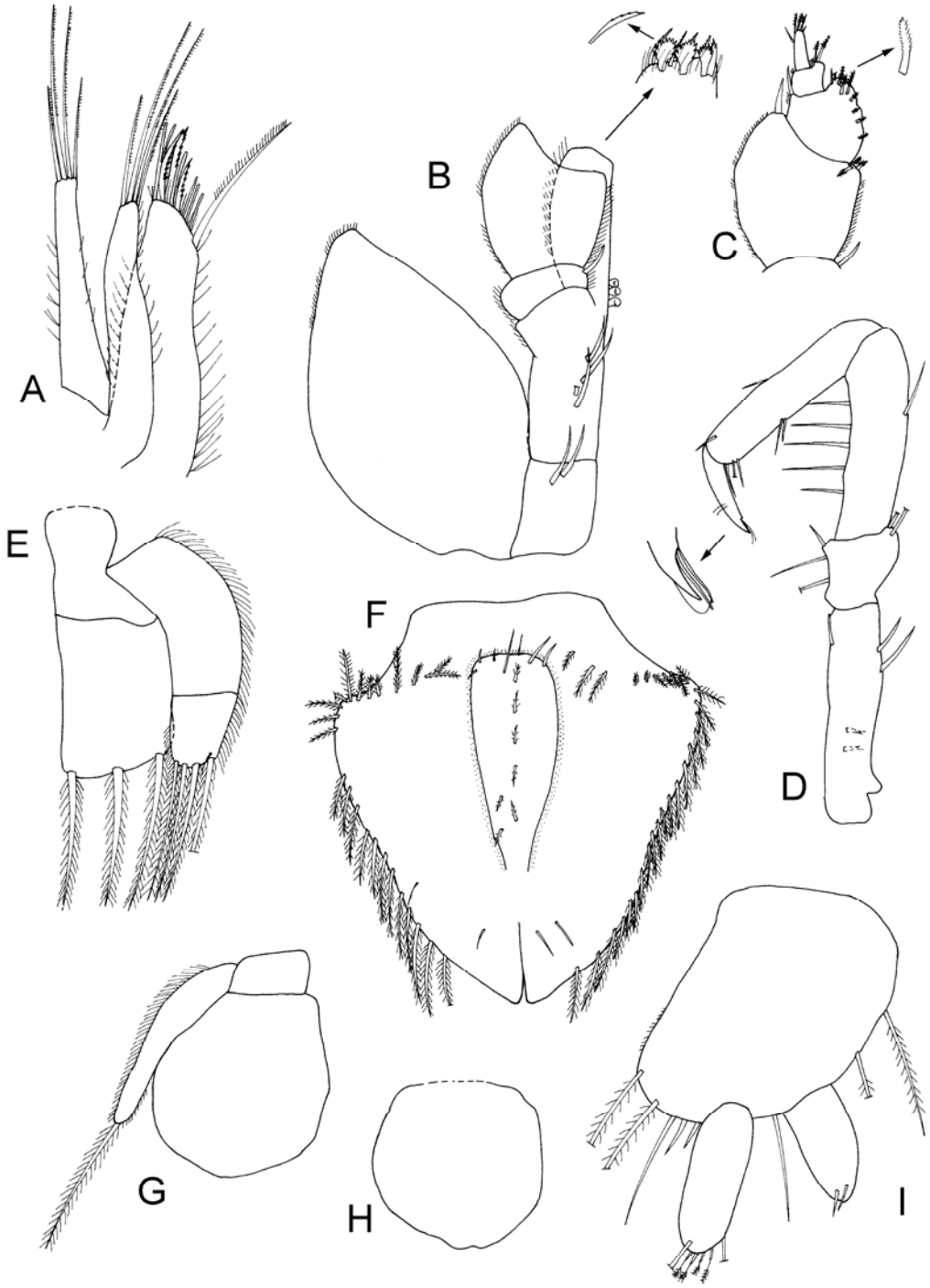

A
B
C
D
E
F
G
H
I

Figure 4.8 *Epikopais pilosus* n. sp. A–C, female holotype, 2.4 mm (NMV XXXX); D, F, female paratype, 2.3 mm (NMV XXXX); E , G, male paratype, 2.0 mm (NMV XXXX). A, lateral view; B, dorsal view; C, cephalon; D, ventral view of pereonite 7; E, right antenna 2; F, left antenna 1; G, right antenna 1. Scale bar = 1 mm, for dorsal and lateral views only.

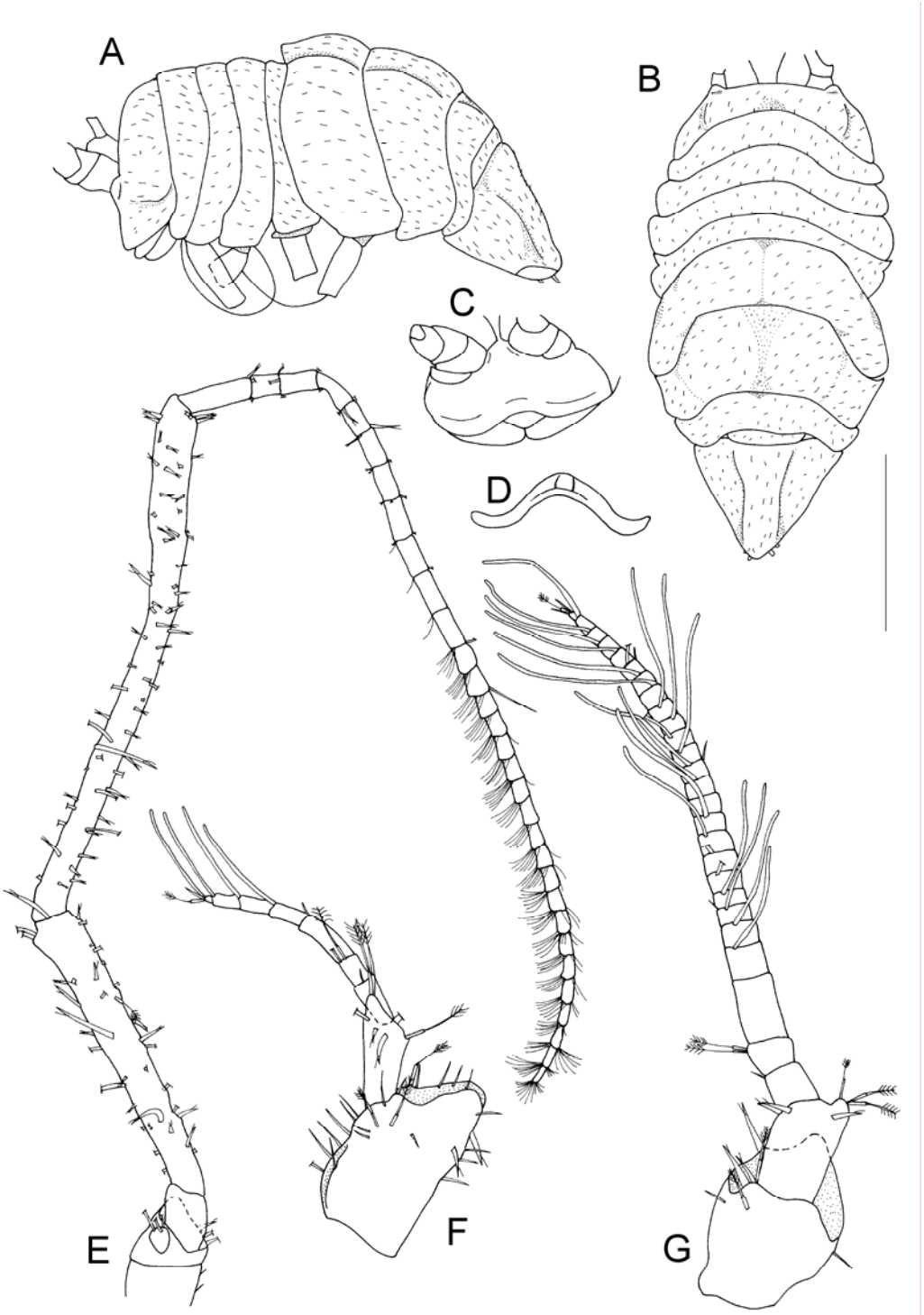

A
B
C
D
E
F
G

Figure 4.9 *Epikopais pilosus* n. sp. All figures from female paratype, 2.3 mm (NMV XXXX). A, left mandible; B, left mandibular molar; C, right mandible; D, right mandible molar; E, left maxilla 1; F, left maxilla 2; G, right maxilliped palp; H, right maxilliped; I, right maxilliped endite; J, right pereopod 1.

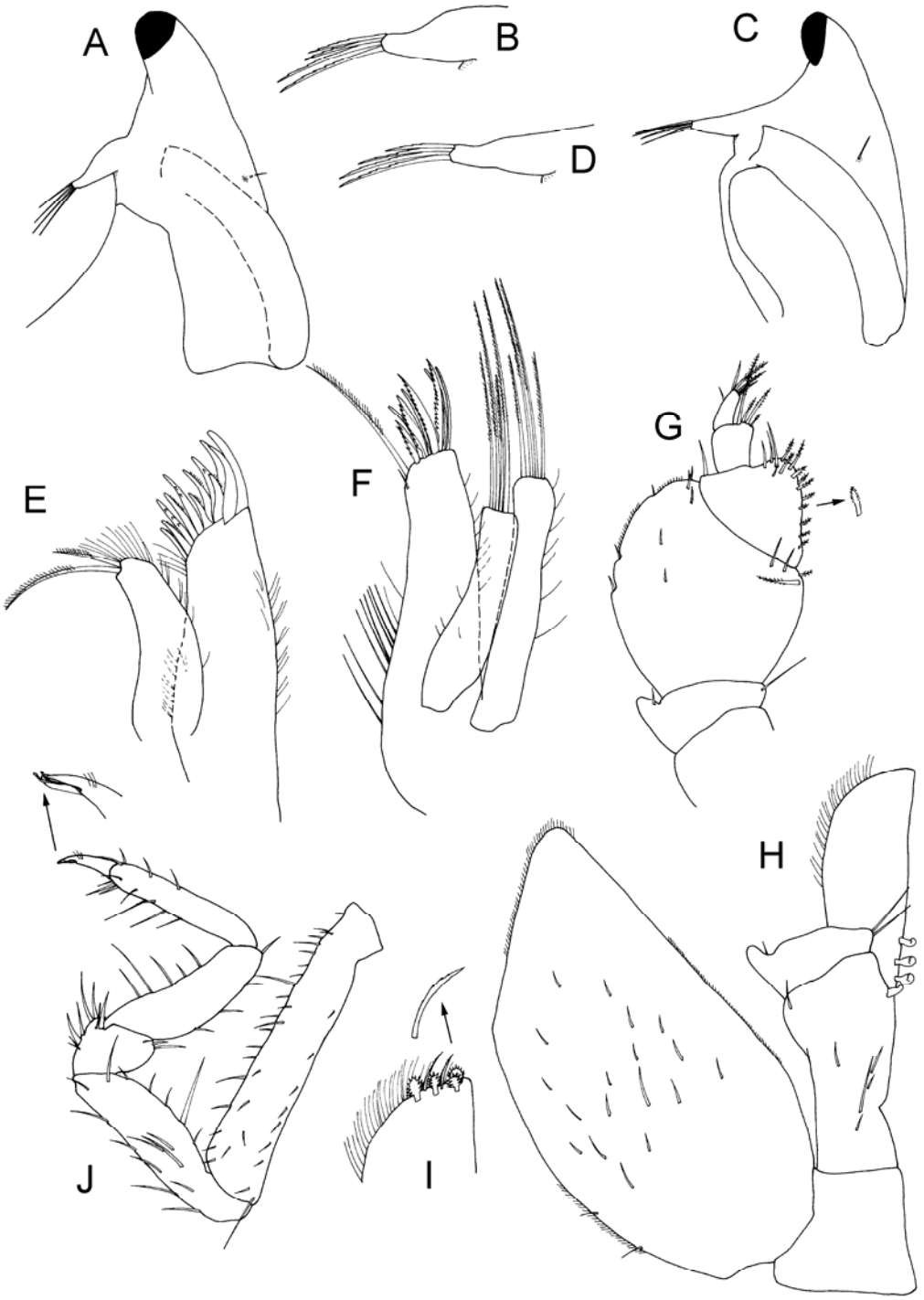

A
B
C
D
E
F
G
H
I
J

Figure 4.10 *Epikopais pilosus* n. sp. A–D, female paratype, 2.3 mm (NMV XXXX); E, female paratype, 2 mm (NMV XXXX). A, left pereopod 2; B, left pereopod 5; C, right pereopod 4; D, left pereopod 3; E, operculum.

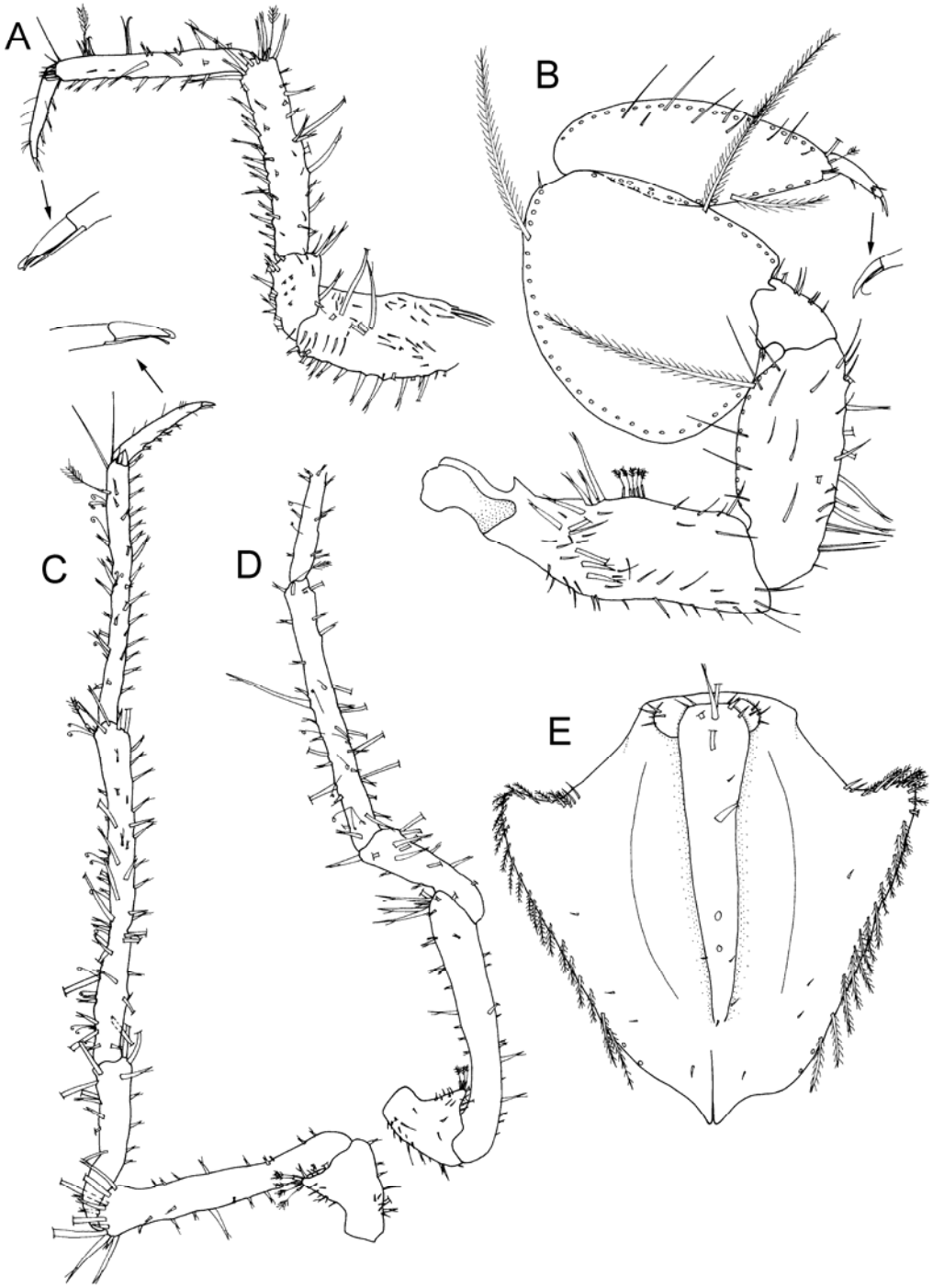

A
B
C
D
E

Figure 4.11 *Epikopais pilosus* n. sp. A, B, E, female paratype, 2.3 mm (NMV XXXX); C, D, male paratype, 2 mm (NIWA XXXX). A, right pereopod 6; B, left pereopod 7; C, pleopod 1; D, left pleopod 2; E, left uropod.

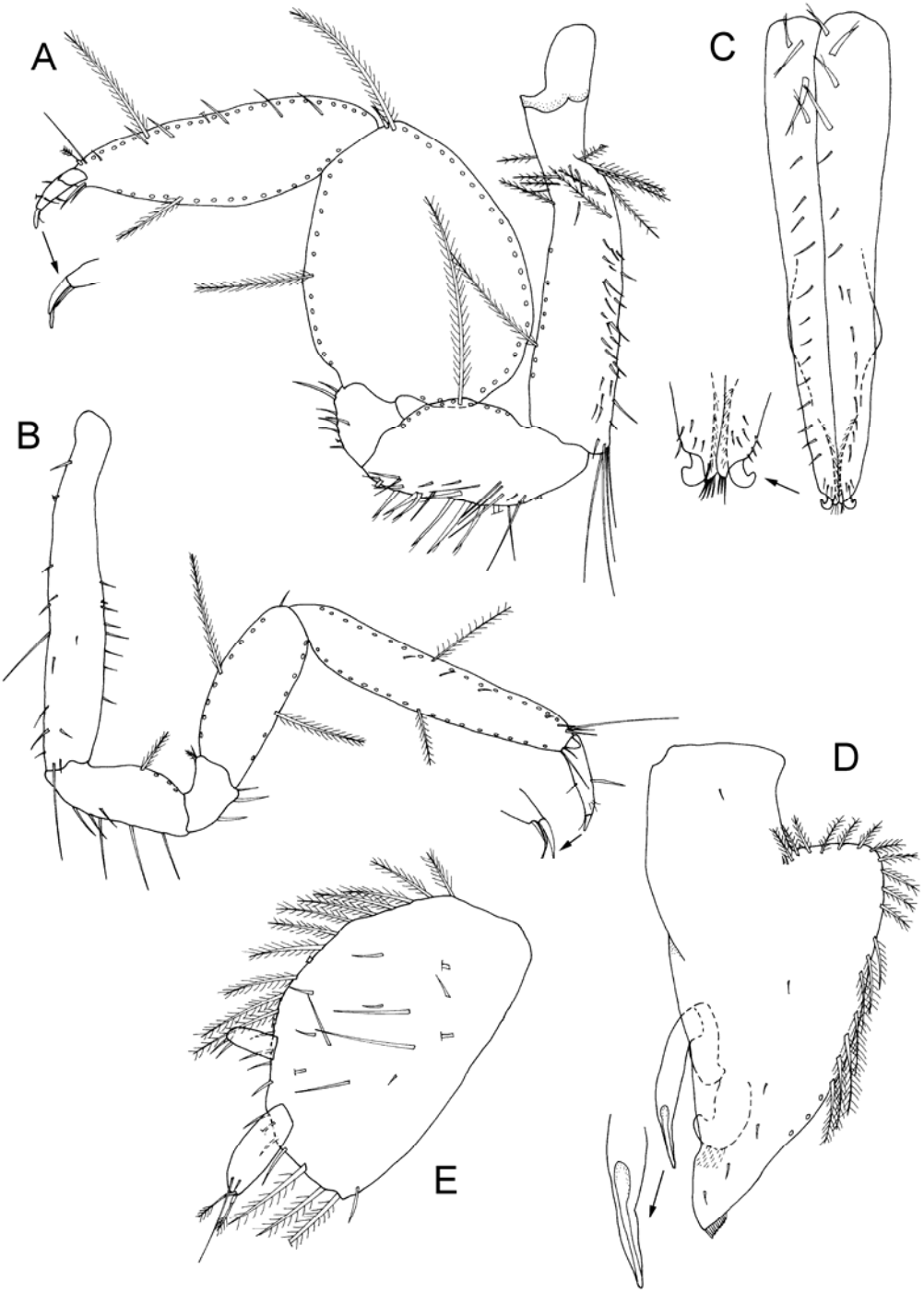

A
C
B
D
E

Figure 4.12 *Epikopais pilosus* n. sp. All figures from female paratype, 2.3 mm (NMV XXXX). A, right pleopod 3; B, right pleopod 4; C, right pleopod 5.

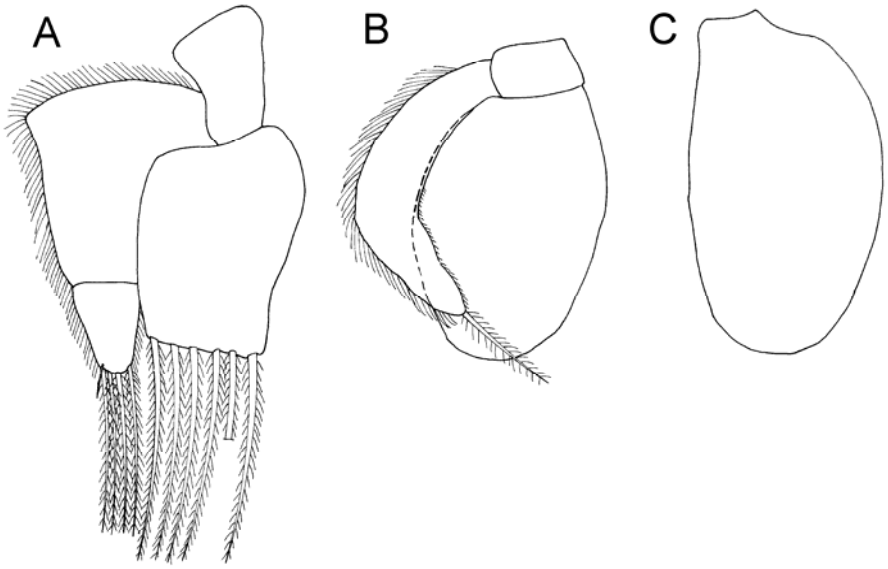

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Figure 4.13 *Epikopais waringa* n. sp. A–E, female holotype, 2.0 mm (NMV XXXX); F, female paratype, 2.0 mm (NMV XXXX); G, H, male paratype, 1.5 mm (NMV J18859). A, dorsal view, natasome curled under; B, dorsal view, natasome flat; C, cephalon; D, lateral view; E, dorsal view of pleon; F, left antenna 1; G, right antenna 2; H, left antenna 1. Scale bar = 1 mm, for dorsal and lateral views only.

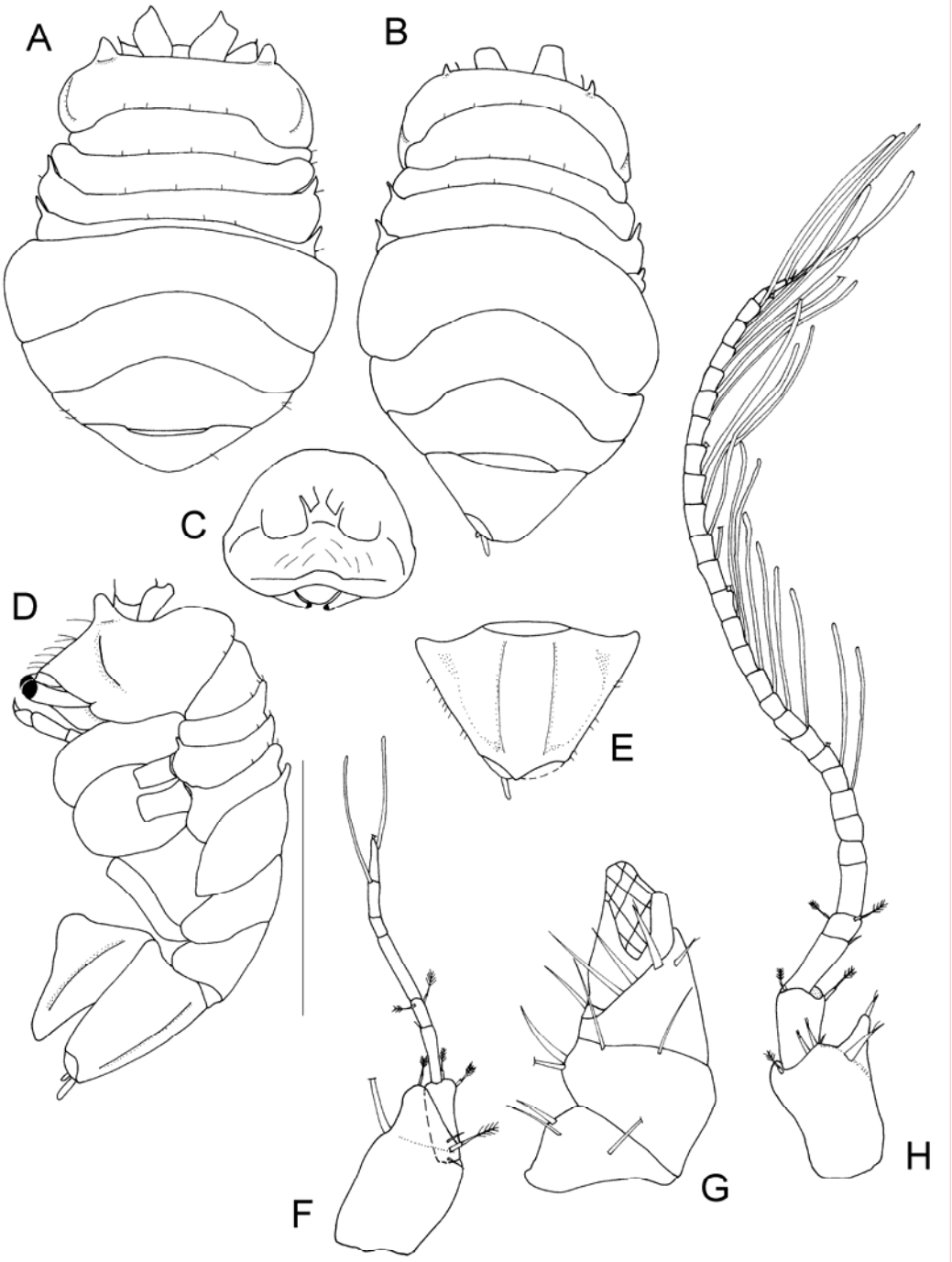
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Figure 4.14 *Epikopais waringa* n. sp. A–I, male paratype 1.5 mm (NMV J18859); J, female paratype, 2 mm (NMV XXXX). A, right mandible; B, right mandibular molar; C, left mandible; D, left mandibular molar; E, left maxilla 1; F, right maxilla 2; G, right maxilliped endite; H, right maxilliped; I, left pereopod 1; J, operculum.

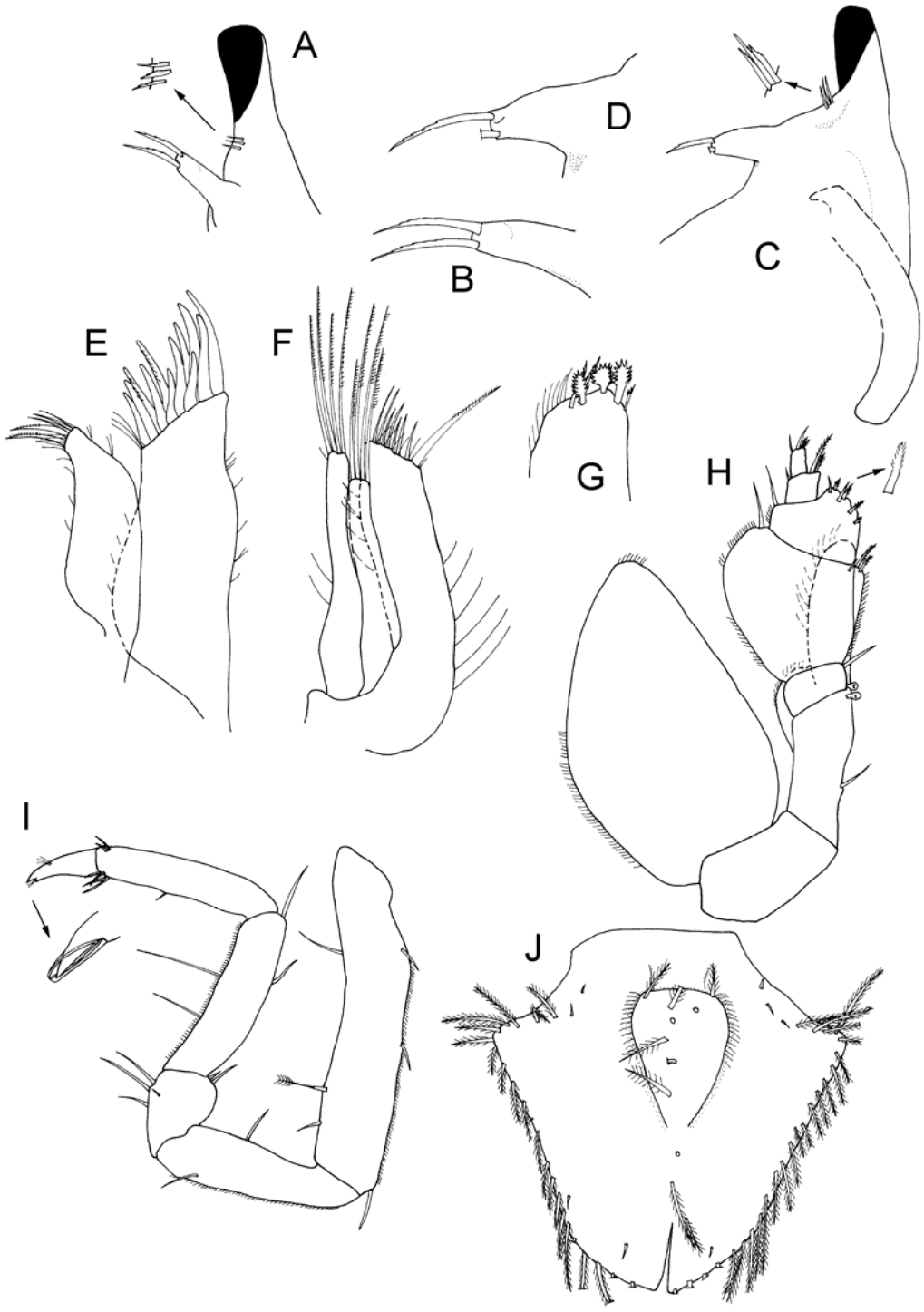
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Figure 4.15 *Epikopais waringa* n. sp. All figures from male paratype, 1.5 mm (NMV J18859). A, right pereopod 5; B, left pereopod 6; C, right pereopod 7; D, left pleopod 3; E, right pleopod 4; F, left pleopod 5.

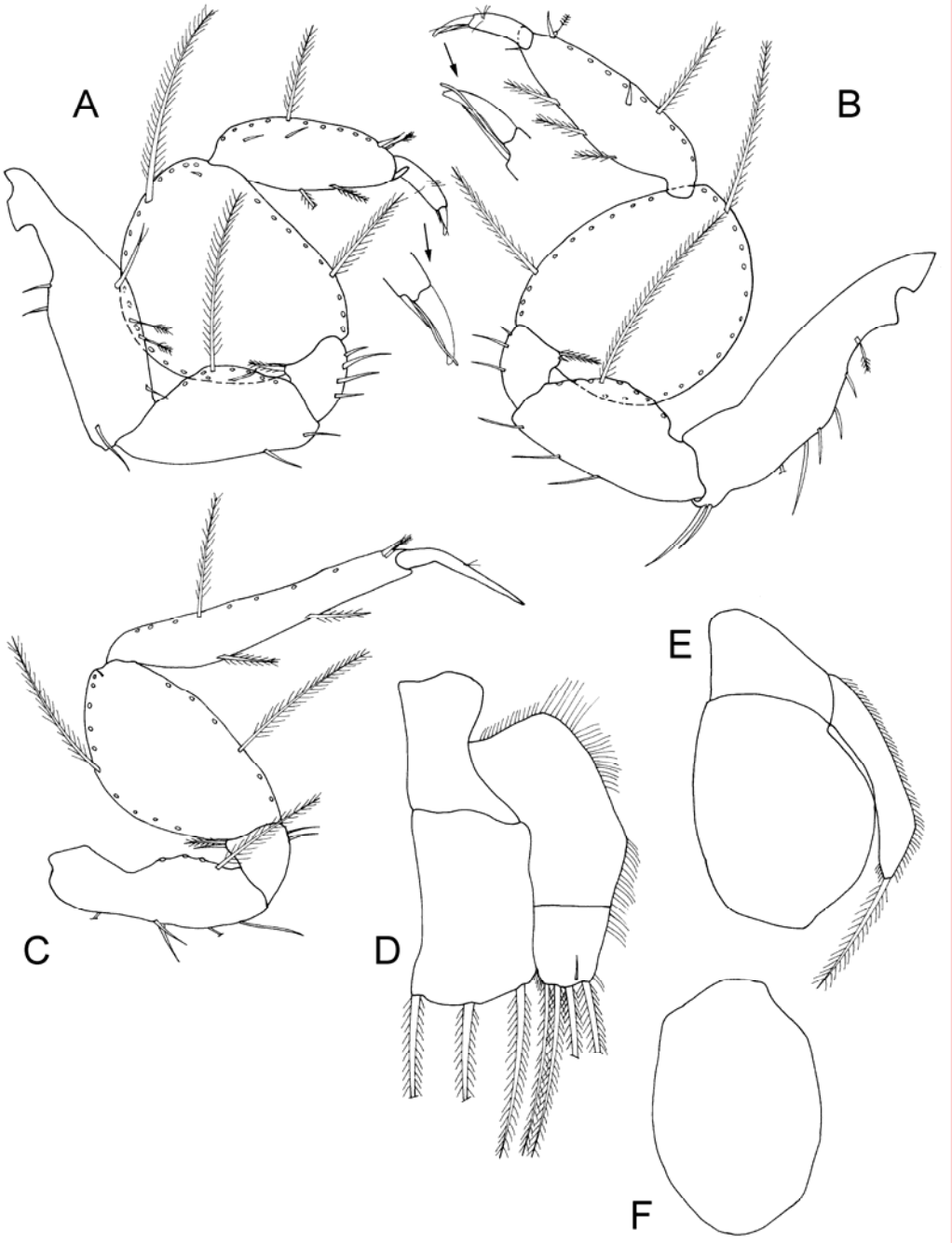
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Figure 4.16 *Epikopais waringa* n. sp. All figures from male paratype, 1.5 mm (NMV J18859). A, male pleopod 1; B, left pleopod 2; C, left pleopod 2 stylet; D, left uropod; E, endopod and exopod of left uropod.

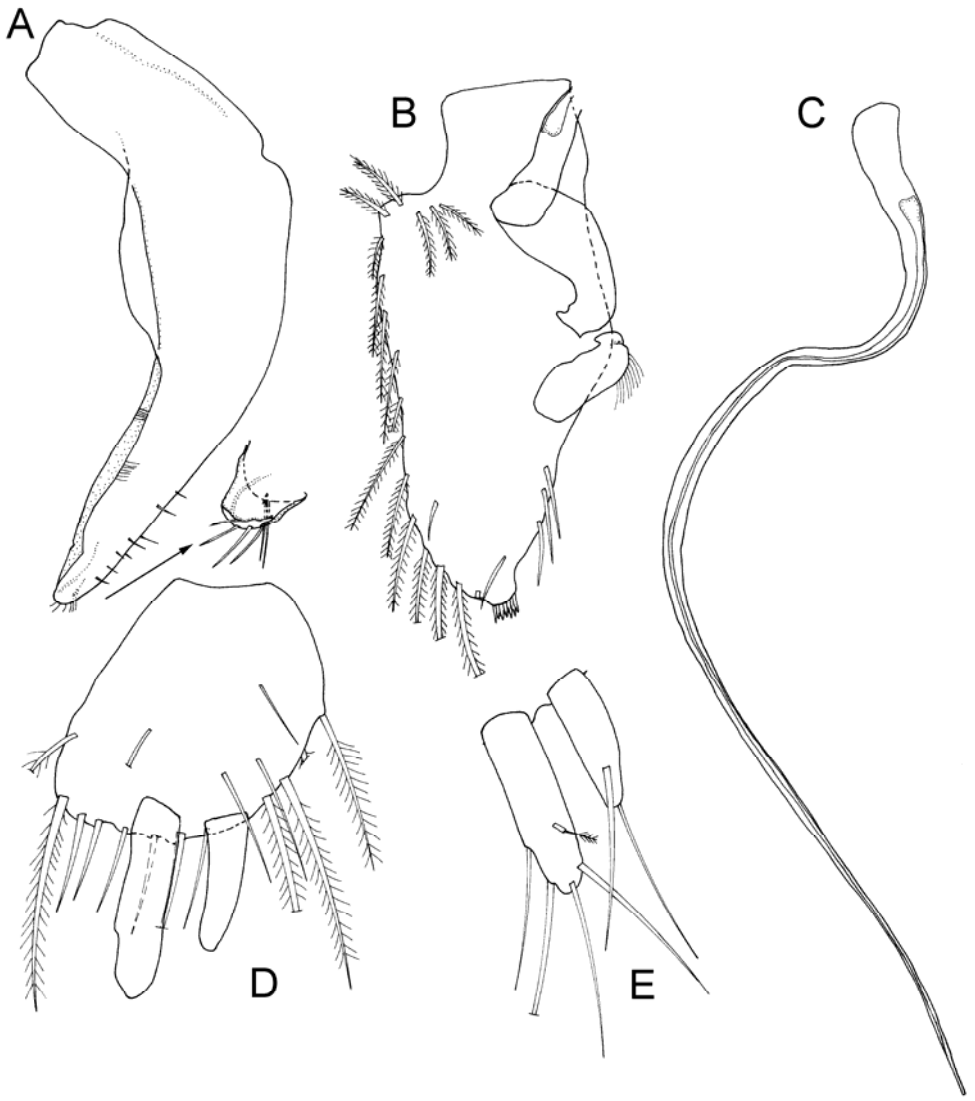
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Figure 4.17 *Ilyarachna aculeatus* n. sp. A–E, male holotype, 3.2 mm (NIWA XXXX); F, H–J, female paratype 3.5 mm (NIWA XXXX); G, male paratype 3.5 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, lateral view of ventral surface of pereonite 7; E, ventral view of pereonite 7 and pleon; F, left antenna 1; G, left antenna 1; H, left antenna 2; I, left mandible; J, right mandible. Scale bar = 1 mm, for dorsal and lateral views only.

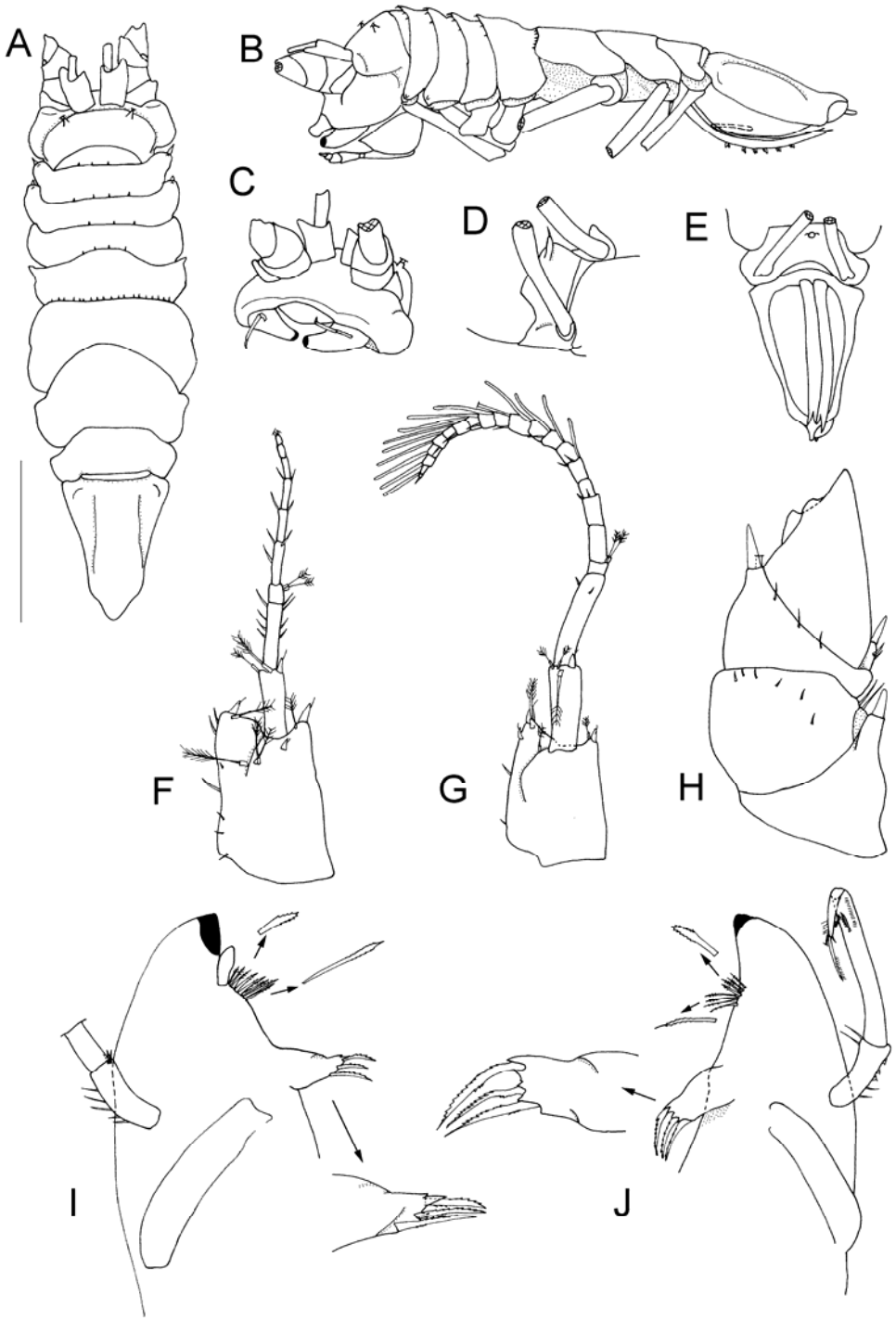
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Figure 4.18 *Ilyarachna aculeatus* n. sp. A–D, G, female paratype 3.5 mm (NIWA XXXX); E, F, male paratype 3.5 mm (NIWA XXXX). A, left maxilla 1; B, left maxilla 2; C, left maxilliped; D, right pereopod 1; E, left pleopod 2; F, lateral view of pleopod 1; G, left pereopod 7.

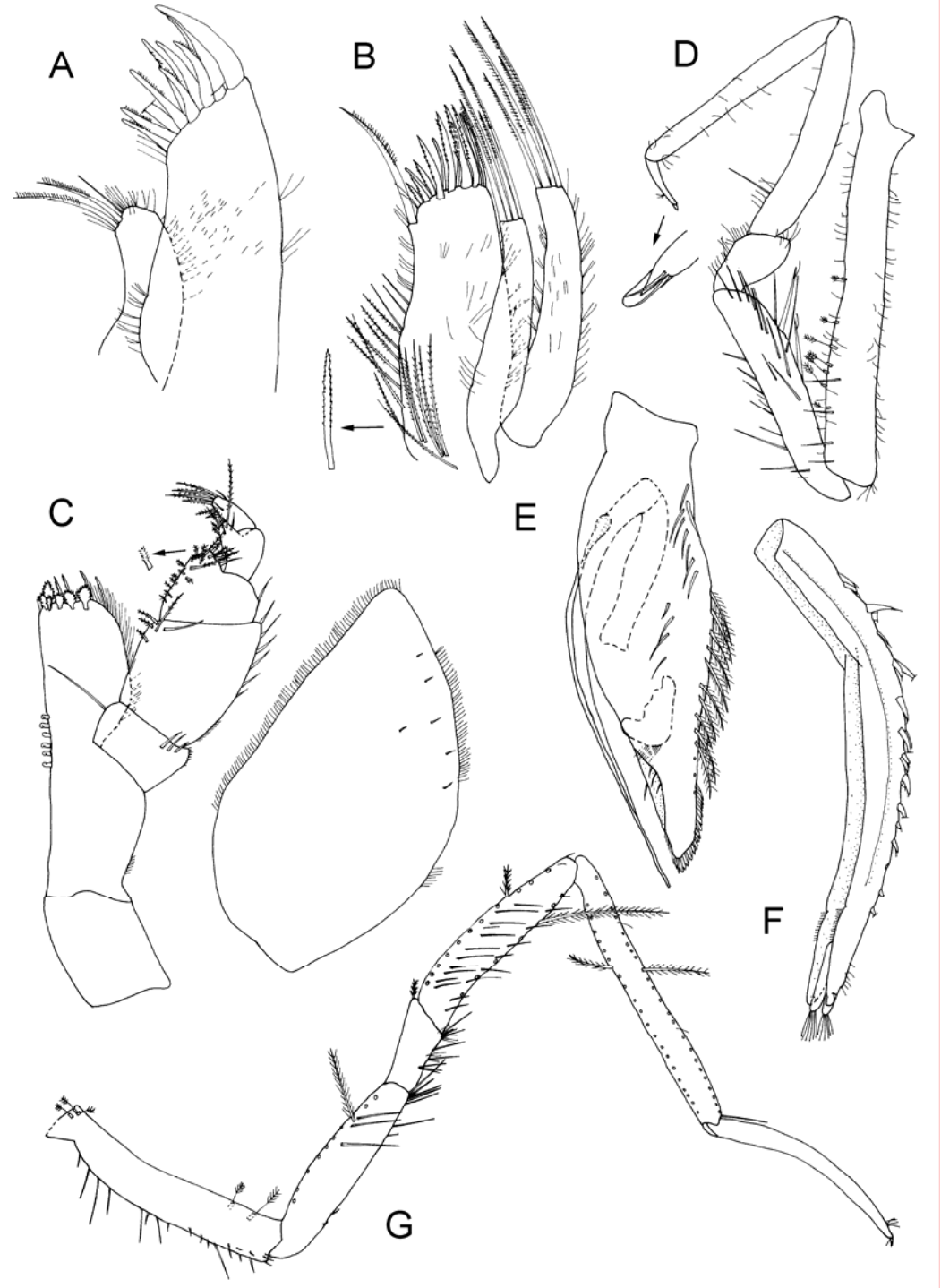
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Figure 4.19 *Ilyarachna aculeatus* n. sp. All figures from female paratype 3.5 mm (NIWA XXXX). A, operculum; B, left pleopod 3; C, left pleopod 4; D, left pleopod 5; E, right uropod; F, endopod of right uropod.

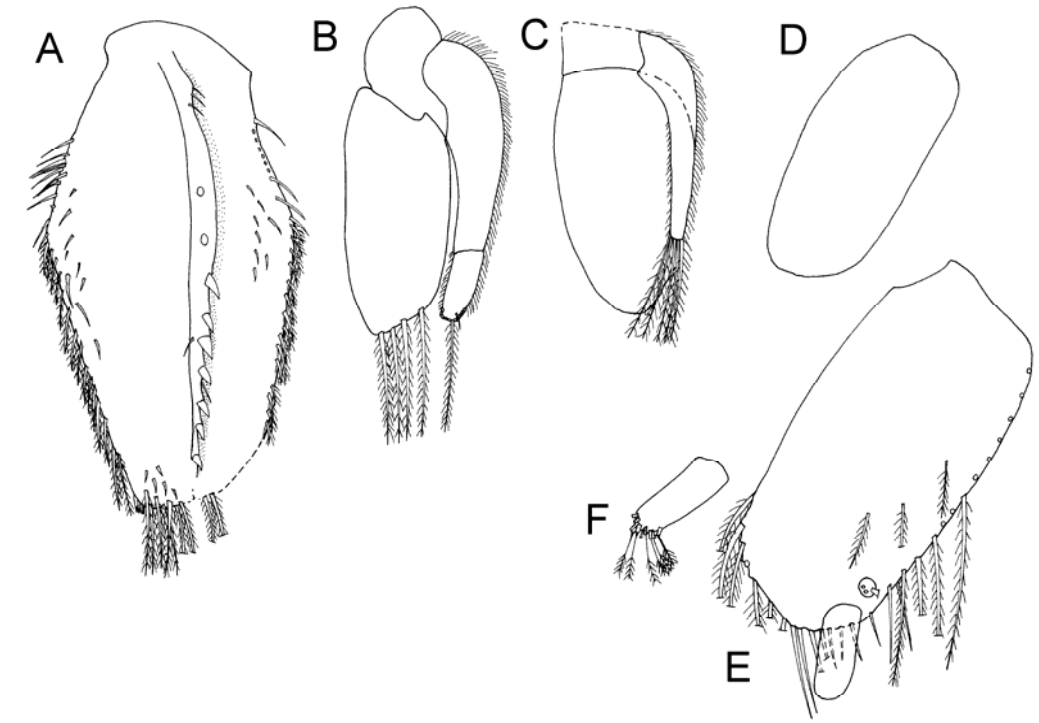
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Figure 4.20 *Ilyarachna australis* n. sp. A–E, female holotype, 4.0 mm (NIWA XXXX); F–M, female paratype 3.5 mm (NIWA XXXX). A, dorsal view; B, cephalon; C, lateral view; D, ventral view of pereonites 6, 7 and pleon; E, angular view of pereonites 6 and 7; F, left antenna 2; G, left antenna 1; H, left mandible; I, right mandible; J, right maxilla 1; K, left maxilliped; L, left maxilliped endite; M, right maxilla 2. Scale bar = 1 mm, for dorsal and lateral views only.

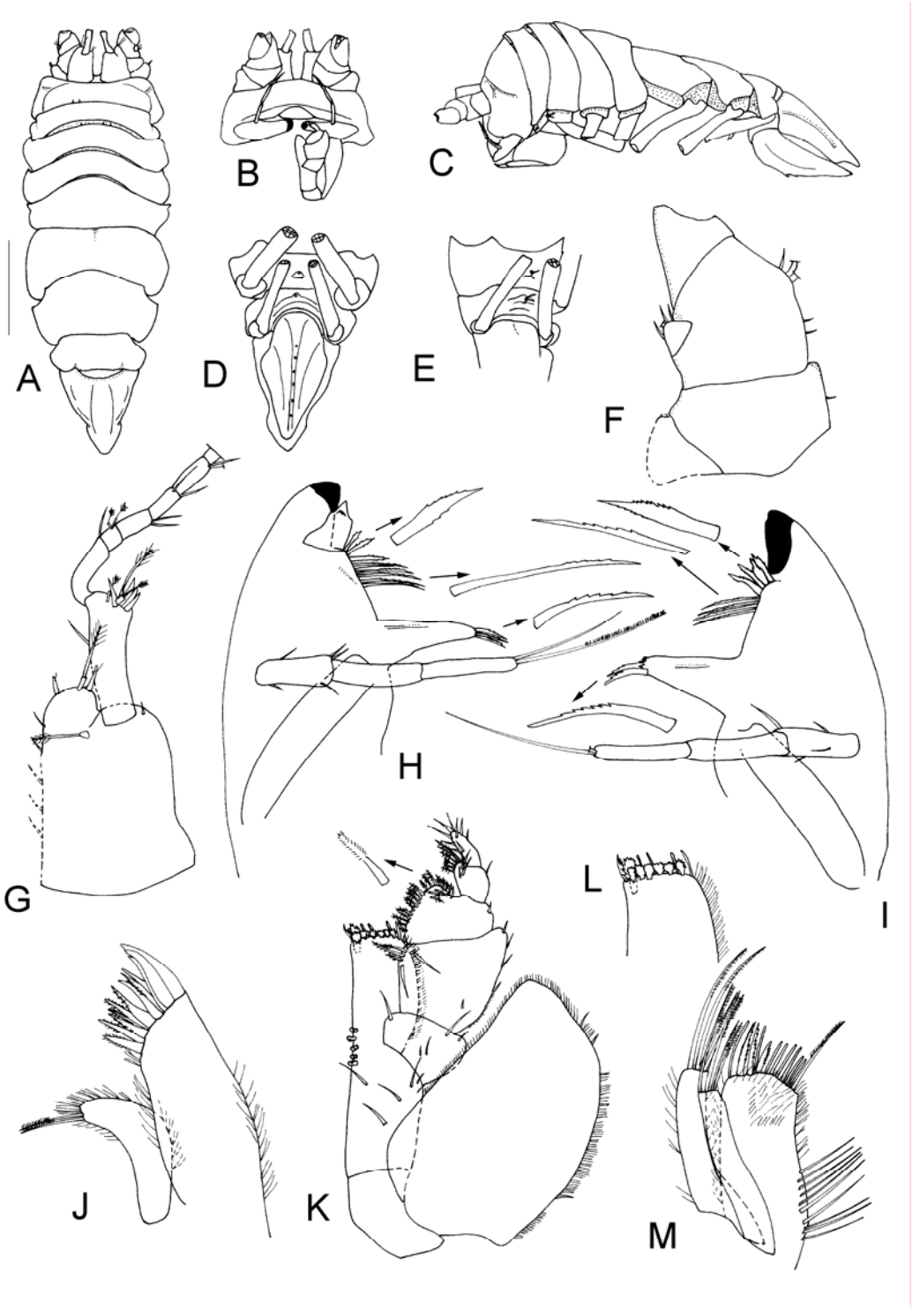
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Figure 4.21 *Ilyarachna australis* n. sp. All figures from female paratype 3.5 mm (NIWA XXXX). A, operculum; B, right pleopod 3; C, right pleopod 4; D, left pleopod 5.

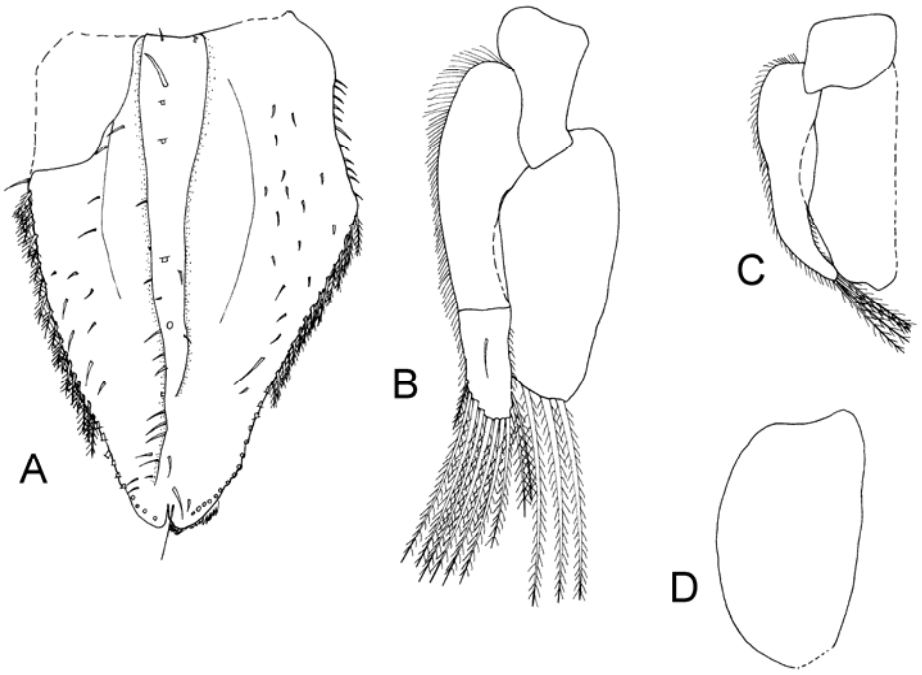
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Figure 4.22 *Ilyarachna cheropin* n. sp. A–D, G, female holotype, 3.0 mm (NMV XXXX); E, F, H, I, male paratype, 3.0 mm (NMV XXXX). A, dorsal view; B, lateral view; C, cephalon; D, dorsal view of pereonites 5–7 and pleon; E, left antenna 2; F, left antenna 1; G, right antenna 1; H, left pereopod 1; I, unguis of left pereopod 1. Scale bar = 1 mm, for dorsal and lateral views only.

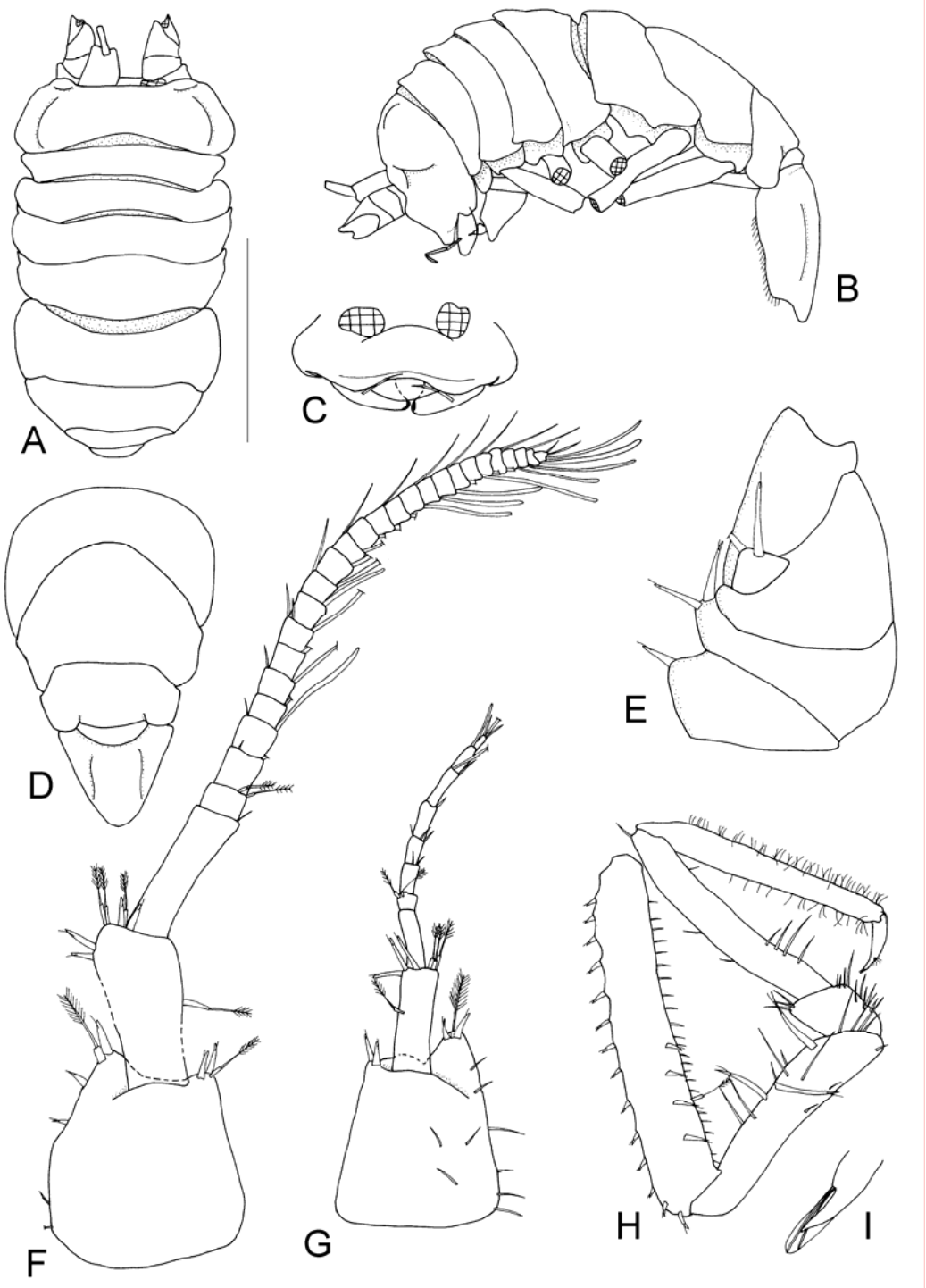
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Figure 4.23 *Ilyarachna cheropin* n. sp. All figures from male paratype, 3.0 mm (NMV XXXX). A, left mandible; B, right mandible; C, left maxilliped; D, left maxilla 1; E, left maxilla 2; F, left uropod.

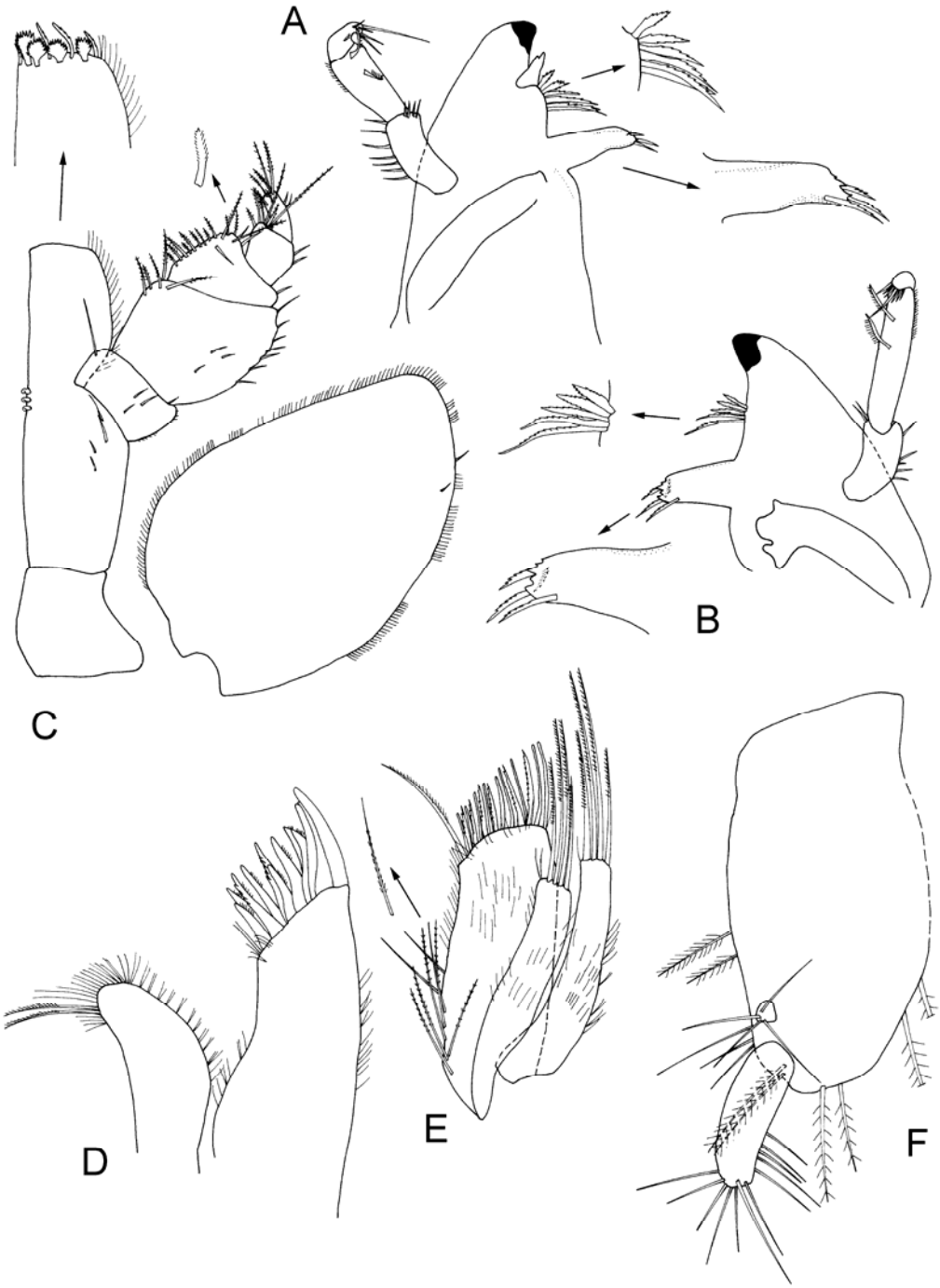
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Figure 4.24 *Ilyarachna cheropin* n. sp. A, B, E, male paratype, 3.0 mm (NMV XXXX); C, female holotype, 3.0 mm (NMV XXXX); D and F, male paratype, 2.5 mm (cephalon missing; NMV XXXX). A, right pereopod 6; B, left pereopod 5; C, operculum; D, left pleopod 2; E, stylet of left pleopod 2 (protopod encrusted in crystals), F, lateral view of pleopod 1.

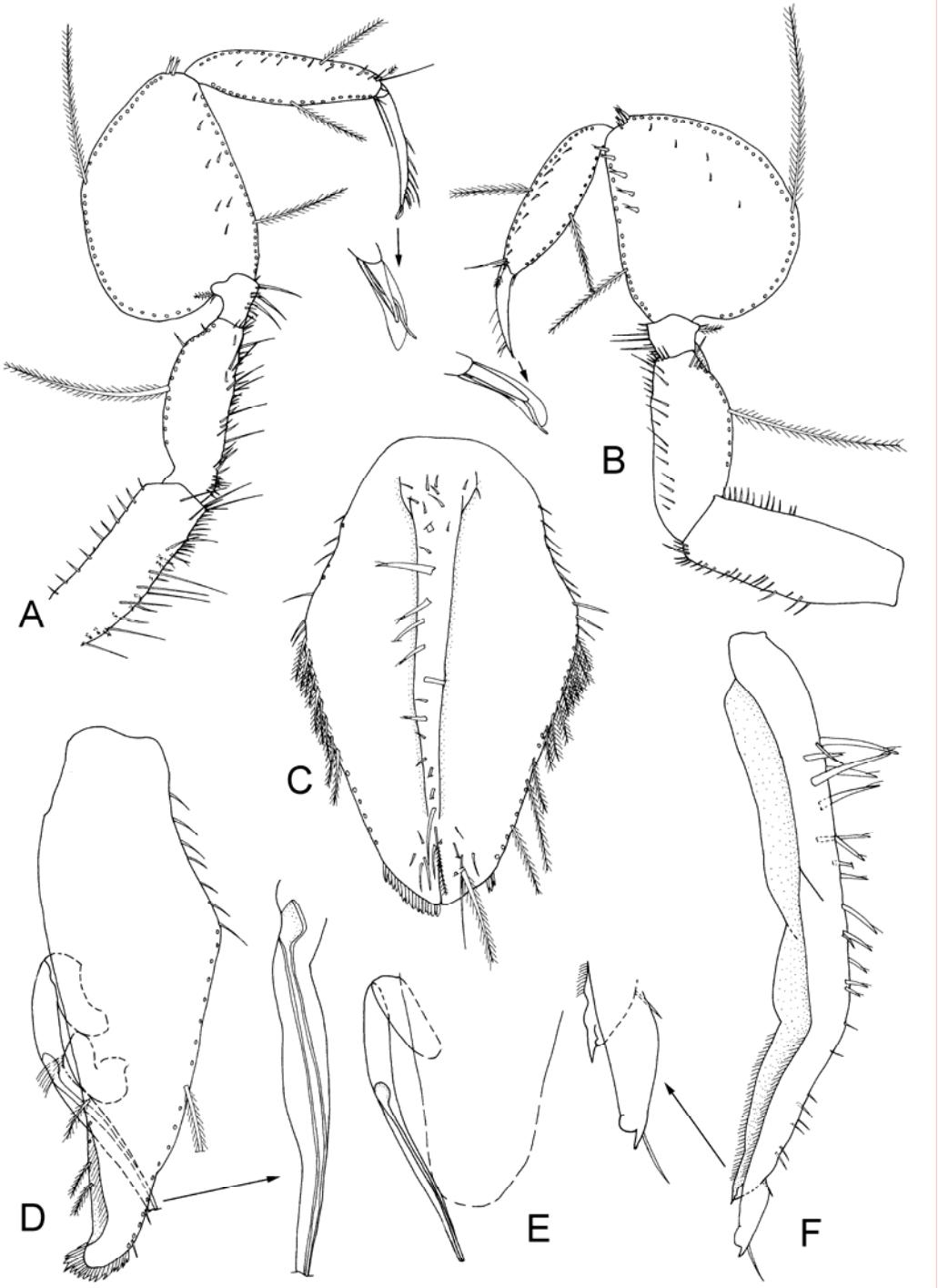
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Figure 4.25 *Ilyarachna cheropin* n. sp. All figures from male paratype 2.5 mm (cephalon missing; NMV XXXX). A, left pleopod 3; B, left pleopod 4; C, left pleopod 5.

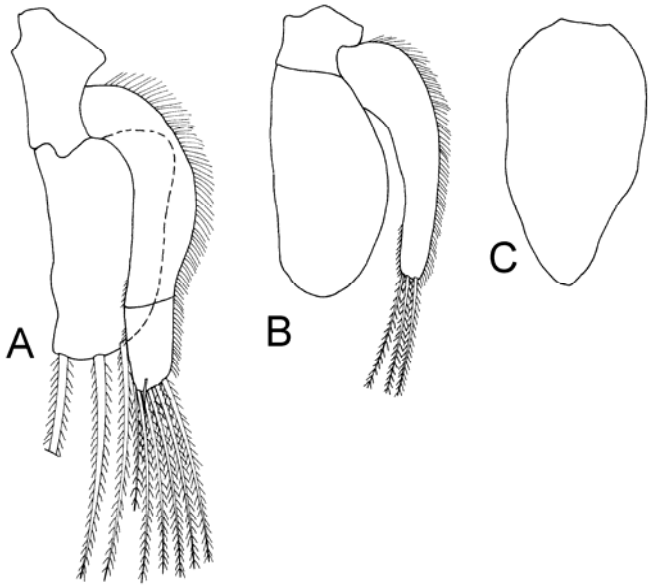
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Figure 4.26 *Ilyarachna crystallum* n. sp. A–C, I, female holotype, 3.2 mm (NMV XXXX); D–H, female paratype, 4.0 mm (NMV XXXX). A, dorsal view; B, lateral view; C, cephalon; D, left antenna 1; E, left antenna 2; F, left mandible; G, right mandible; H, left maxilla 1; I, ventral view of pereonite 7. Scale bar = 1 mm, for dorsal and lateral views only.

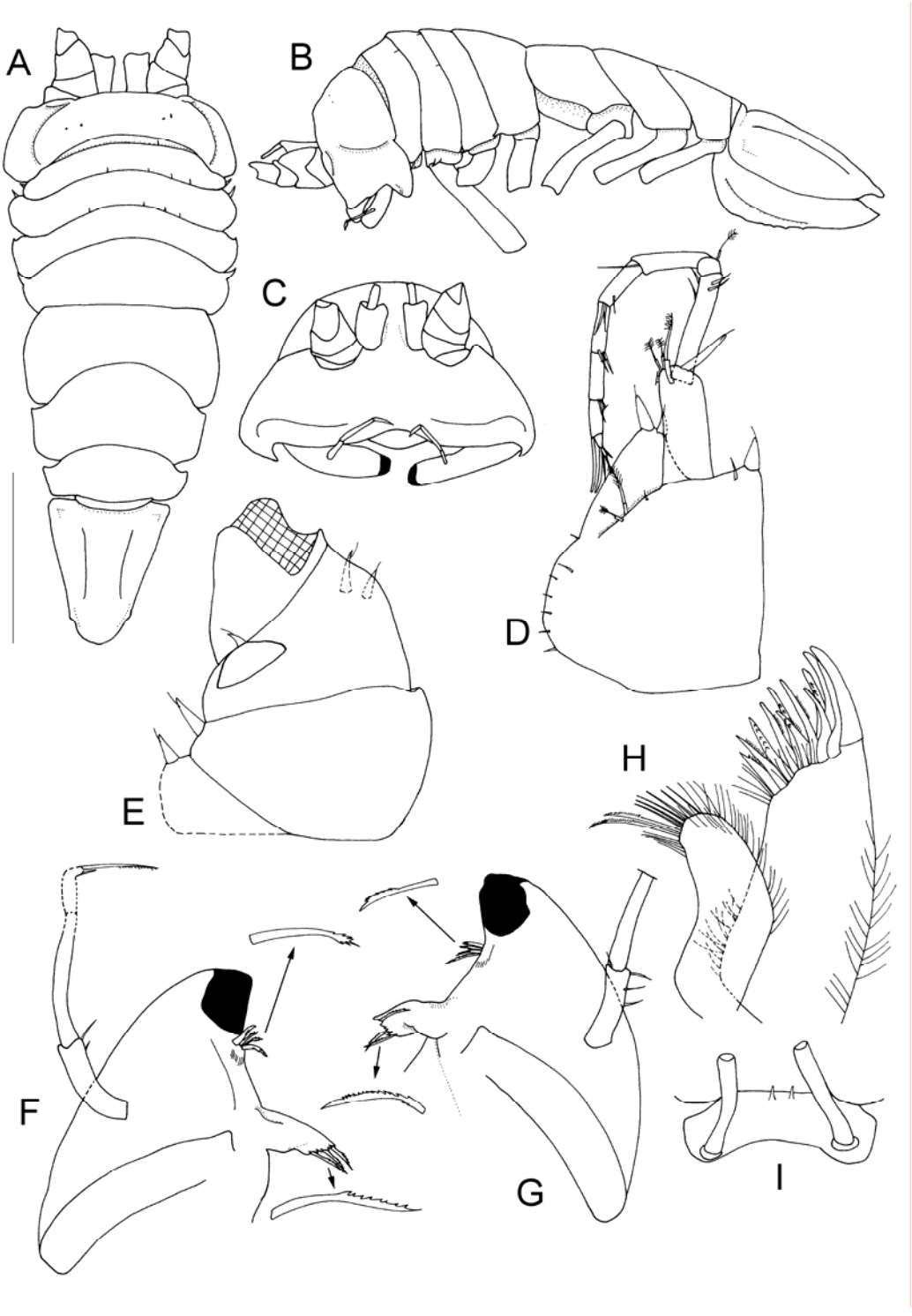
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Figure 4.27 *Ilyarachna crystallum* n. sp. All figures from female paratype, 4.0 mm (NMV XXXX). A, left maxilla 2; B, left maxilliped; C, left uropod; D, operculum; E, right pleopod 3; F, left pleopod 4; G, left pleopod 5.

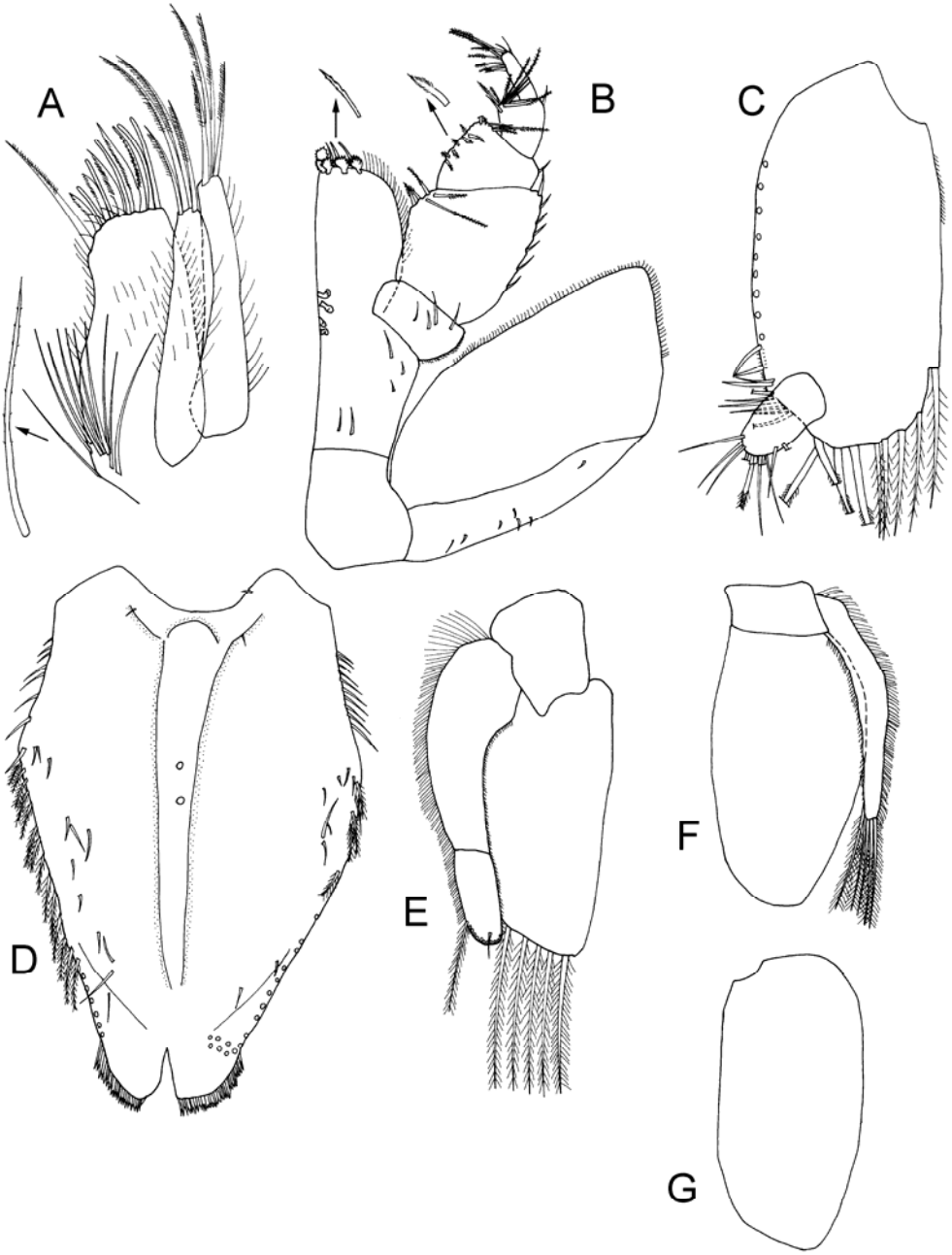
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Figure 4.28 *Ilyarachna flindersi* n. sp. A–D, female holotype, 2.5 mm (NMV XXXX); F, H, female paratype, 4 mm (NMV XXXX); E and G, male paratype, 2.0 mm (NMV XXXX). A, dorsal view; B, lateral view; C, dorsal view of cephalon and pereonite 1; D, cephalon; E, ventral view of pereonite 7; F, left antenna 1; G, left antenna 1; H, right antenna 2. Scale bar = 1 mm, for dorsal and lateral views only.

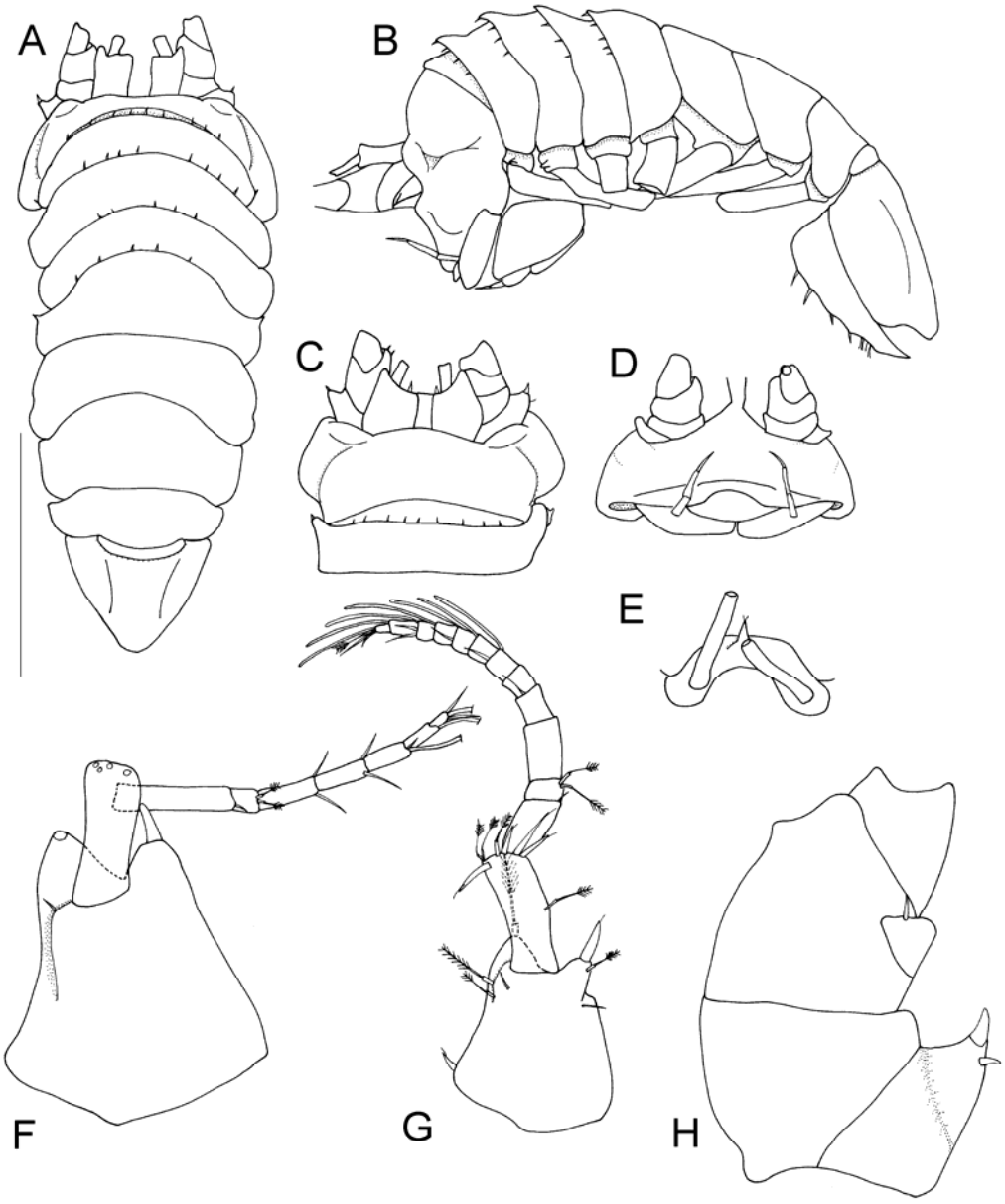
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Figure 4.29 *Ilyarachna flindersi* n. sp. A–F, female paratype, 4.0 mm (NMV XXXX); G–I, female paratype, 3.5 mm (NMV XXXX). A, left mandible; B, right mandible; C, left maxilla 1; D, left maxilliped; E, distal part of left maxilliped endite; F, left maxilla 2; G, right pereopod 1; H, unguis of right pereopod 1; I, left pereopod 6.

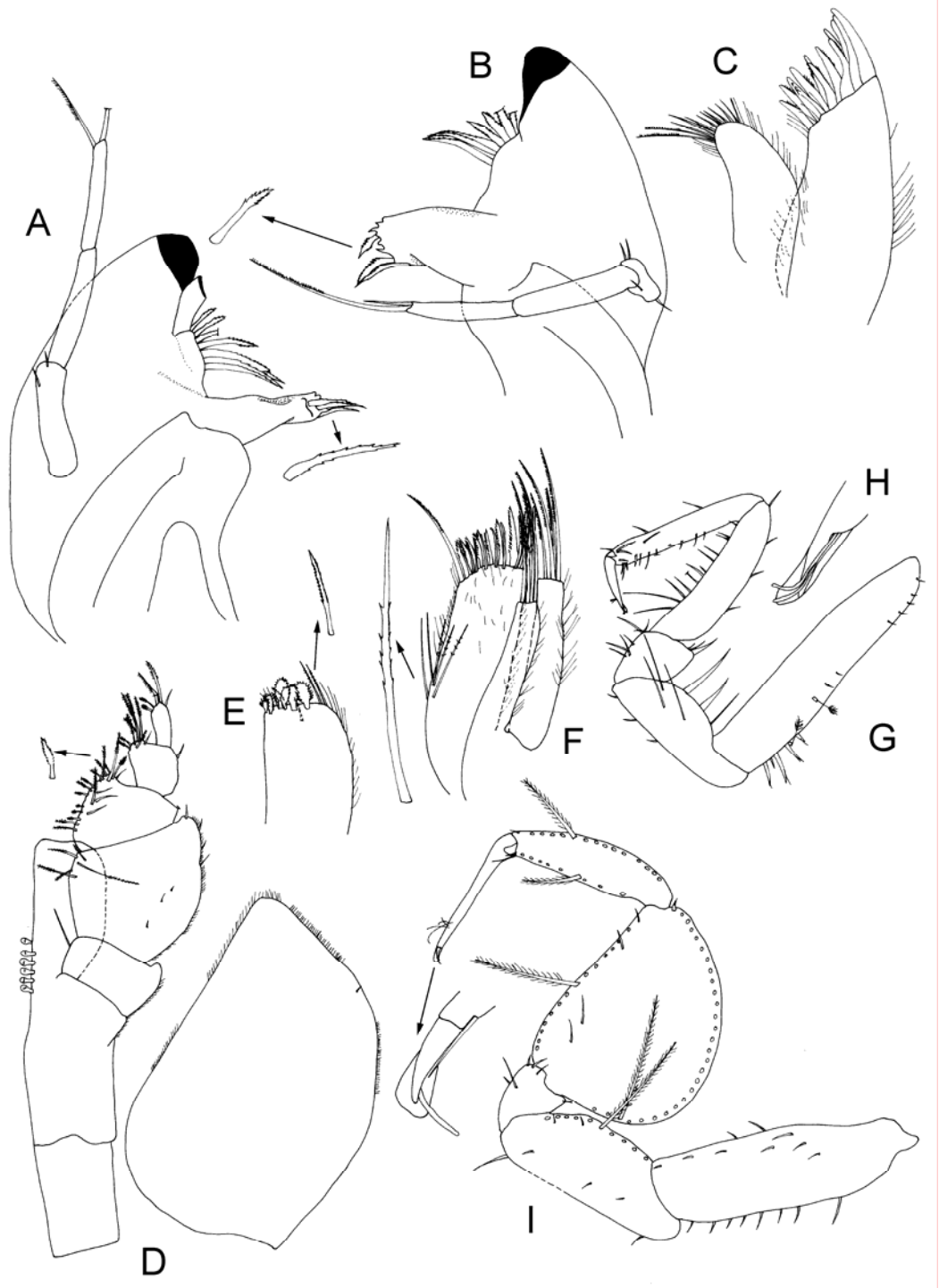
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Figure 4.30 *Ilyarachna flindersi* n. sp. A, E–G, female paratype, 4.0 mm (NIWA XXXX); B–D, male paratype, 2.0 mm (NIWA XXXX); H , I, female paratype, 3.5 mm (NIWA XXXX). A, operculum; B, pleopod 1; C, right pleopod 2; D, exopod of left pleopod 2; E, right pleopod 3; F, right pleopod 4; G, right pleopod 5; H, left uropod; I, endopod of left uropod.

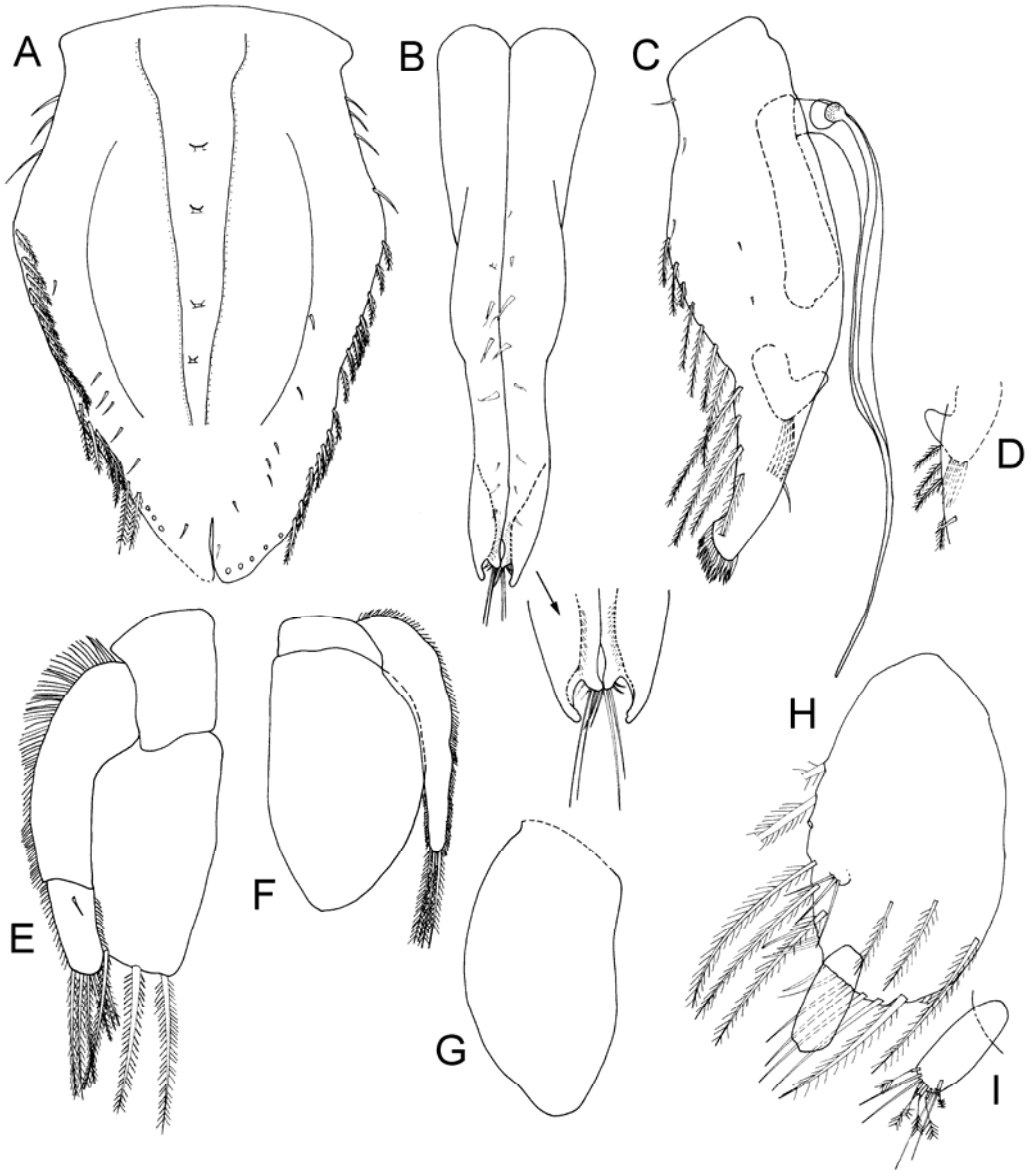
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Figure 4.31 *Ilyarachna franki* n. sp. A–E, female holotype, 9.5 mm (NIWA XXXX); F, G, I , J, female paratype, 8.5 mm (NIWA XXXX); H, male paratype, 6.0 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, angular view of pereonite 7; D, ventral view of pereonite 6, 7 and pleon; E, cephalon; F, left antenna 2; G, left antenna 1; H, right antenna 1; I, right maxilla 1; J, right maxilla 2. Scale bar = 1 mm, for dorsal and lateral views only.

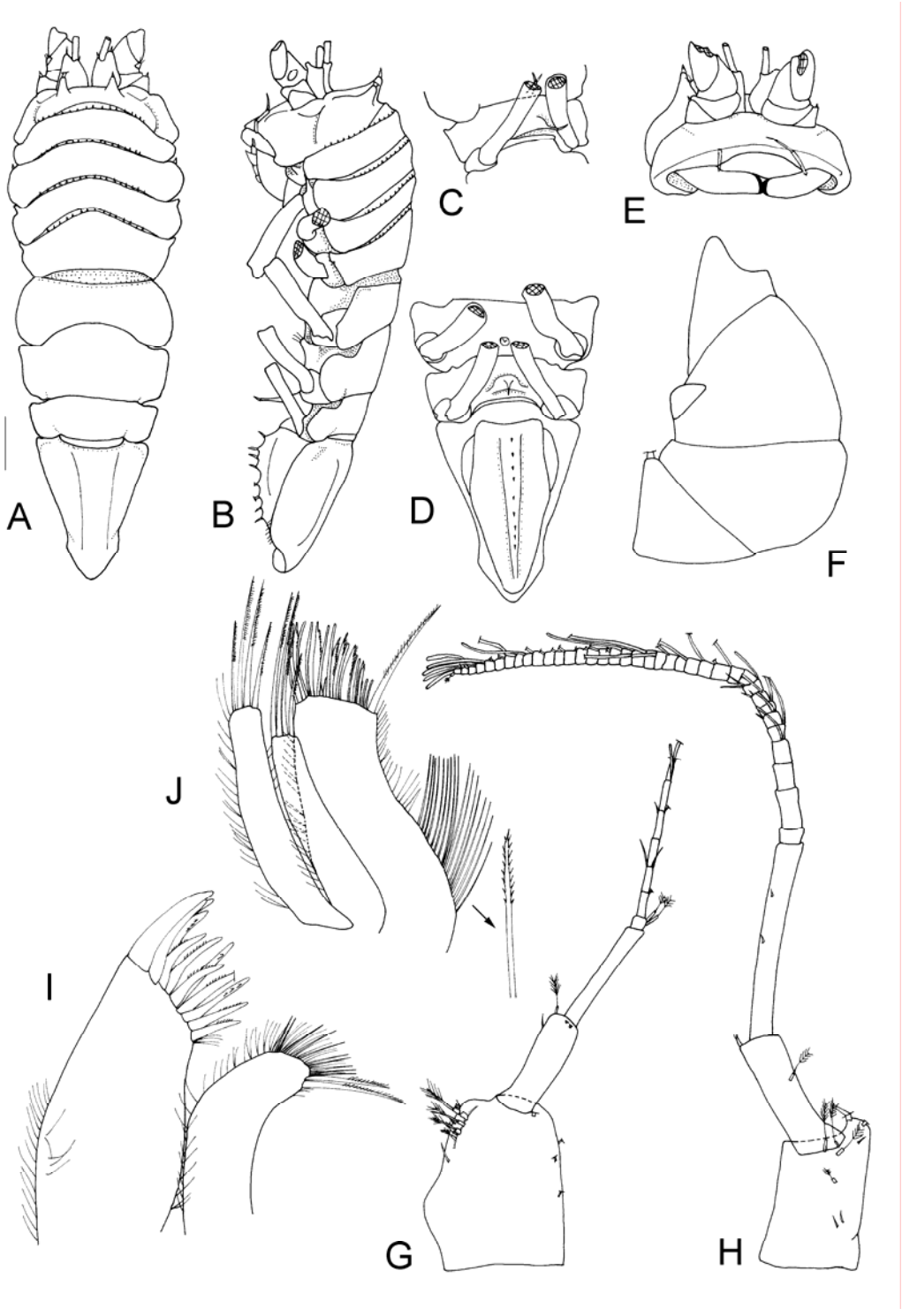
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Figure 4.32 *Ilyarachna franki* n. sp. A–C, female paratype, 8.5 mm (NIWA XXXX); E, F, female holotype, 9.5 mm (NIWA XXXX); G–I, male paratype, 6.0 mm (NIWA XXXX). A, left mandible; B, right mandible; C, left maxilliped; D, left maxilliped endite; E, right pereopod 1; F, right pereopod 1 unguis; G, pleopod 1; H, distal end of pleopod 1; I, left pleopod 2.

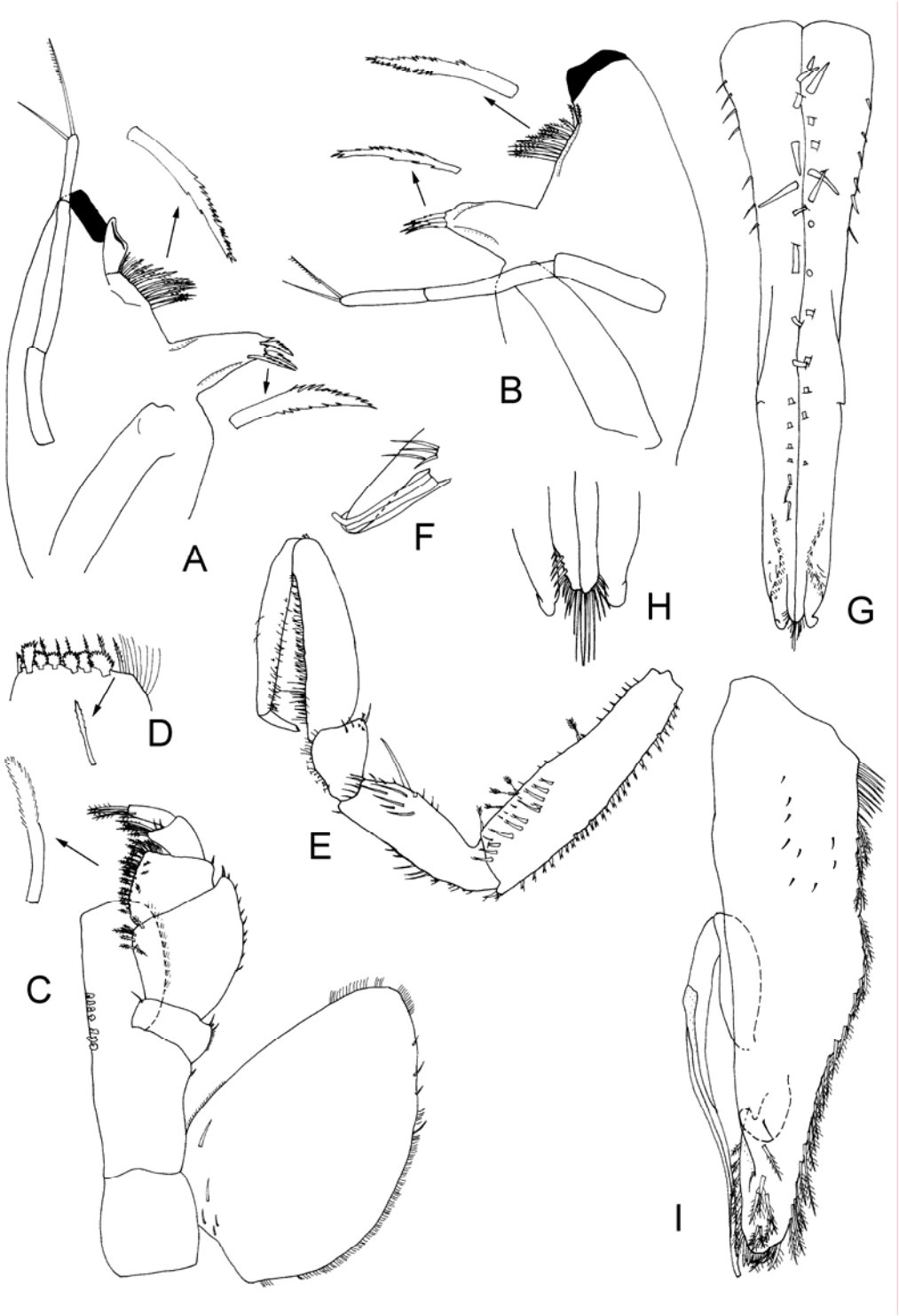
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Figure 4.33 *Ilyarachna franki* n. sp. All figures from female paratype, 8.5 mm (NIWA XXXX). A, operculum; B, left pleopod 3; C, left pleopod 4; D, left pleopod 5; E, left uropod.

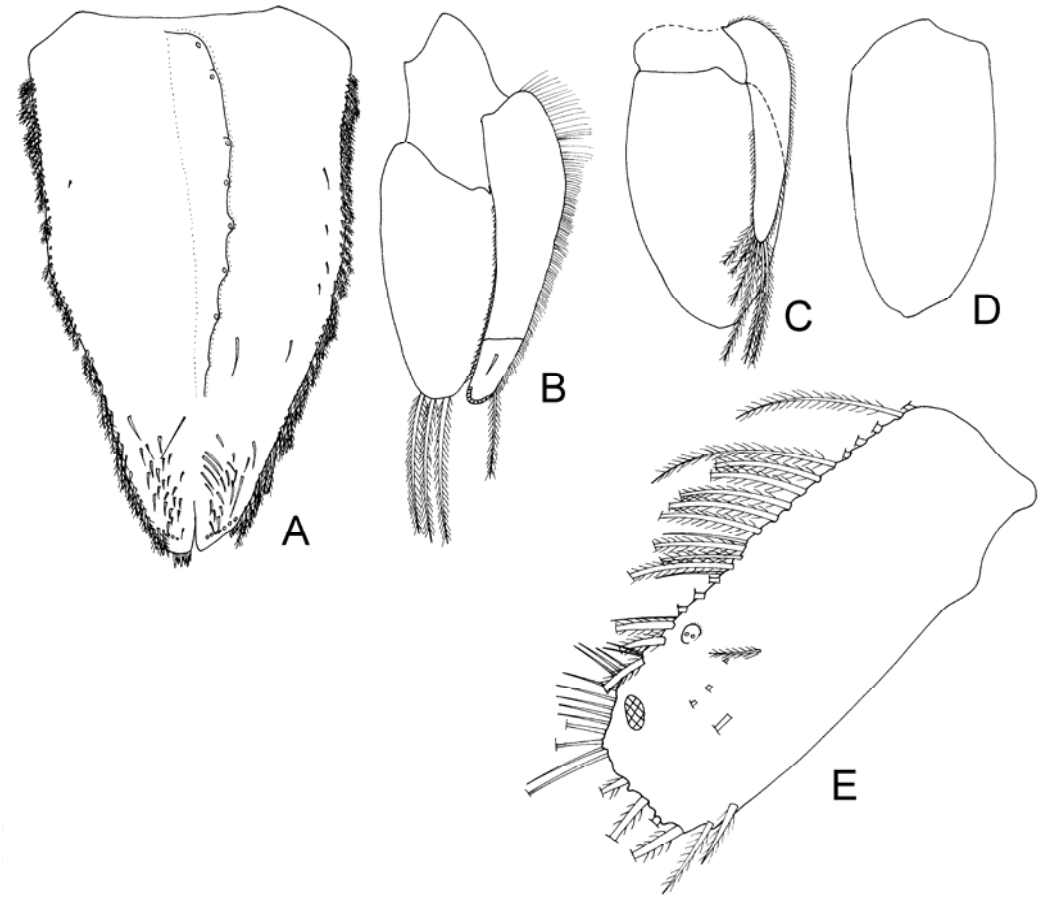
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Figure 4.34 *Ilyarachna moana* n. sp. A–G, female holotype, 6.0 mm (NIWA XXXX); H–I, female paratype 5.5 mm (NIWA XXXX); J, male paratype, 5.0 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, dorsal view of pereonites 4–7 and pleon; D, dorsal view of cephalon, pereonites 1 and 2; E, cephalon; F, ventral view of pereonite 7 and pleon; G, lateral view of pereonite 7; H, right antenna 2; I, right antenna 1; J, right antenna 1

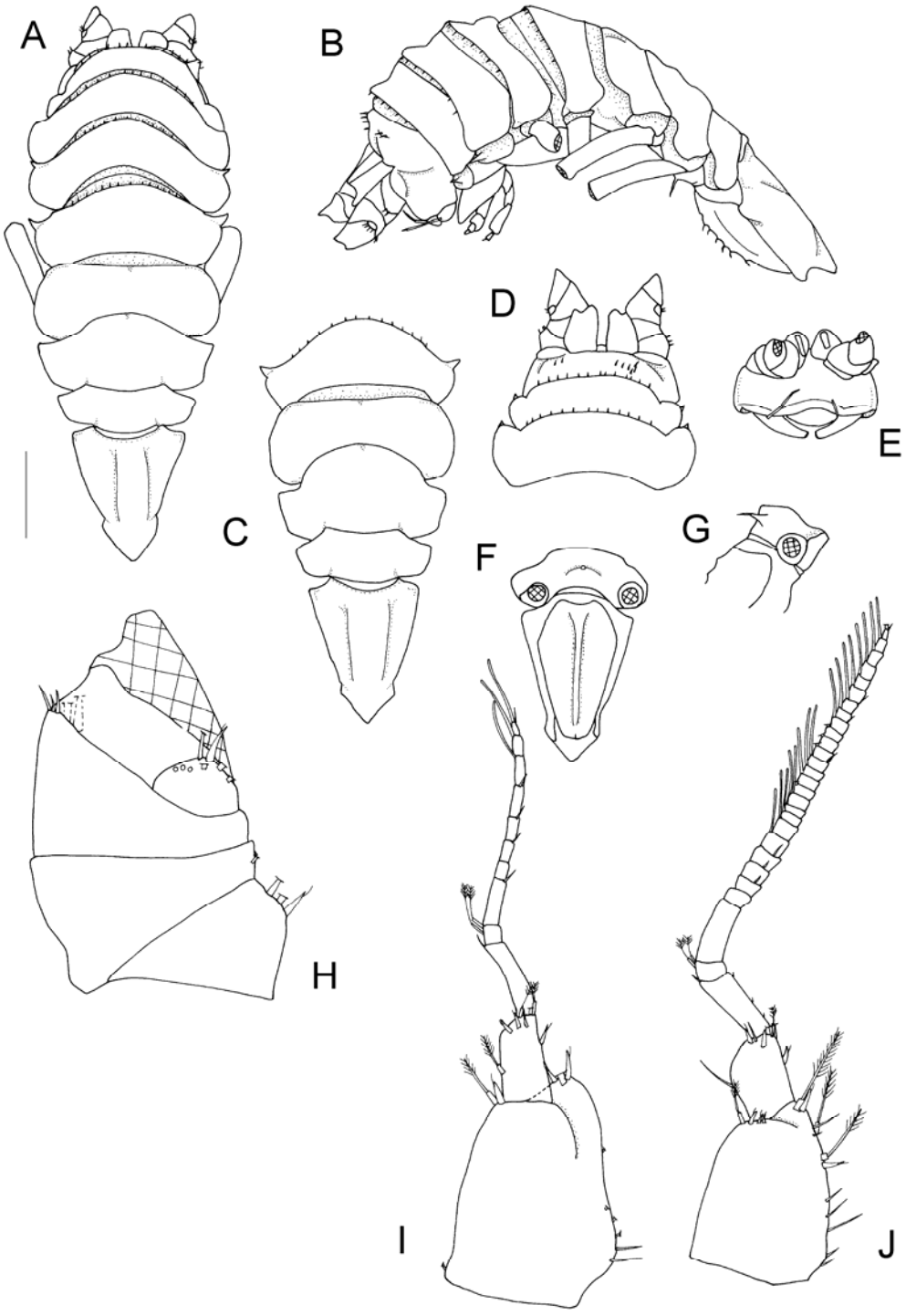
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Figure 4.35 *Ilyarachna moana* n. sp. A–F, female paratype, 5.5 mm (NIWA XXXX); G–H, female holotype, 6.0 mm (NIWA XXXX). A, left mandible; B, right mandible; C, left maxilla 1; D, distal end of left maxilliped endite; E, left maxilliped; F, left maxilla 2; G, right pereopod 1; H, right pereopod 2.

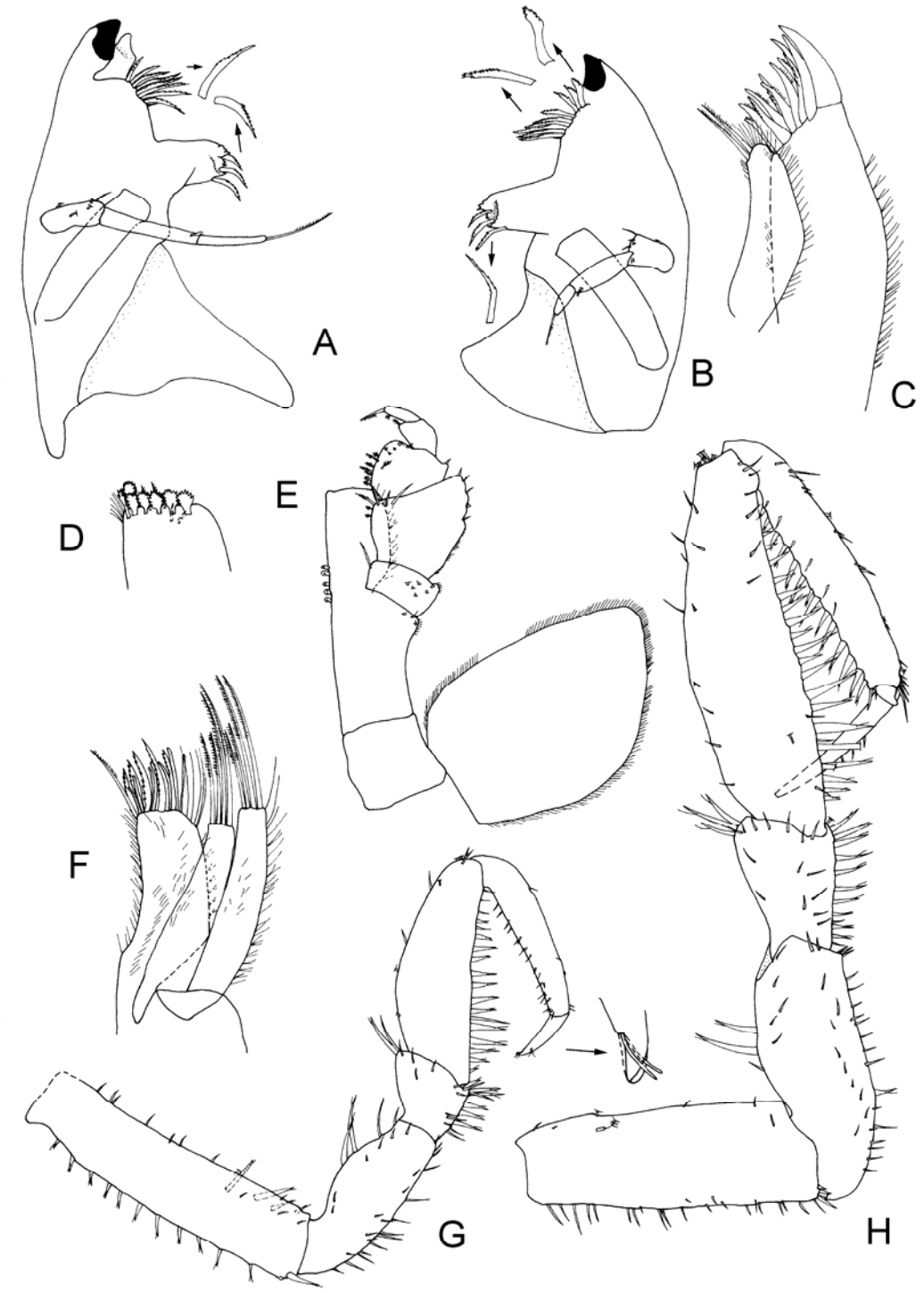
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Figure 4.36 *Ilyarachna moana* n. sp. A, B, female holotype, 6.0 mm (NIWA XXXX); C, F–I, female paratype 5.5 mm (NIWA XXXX); D–E male paratype, 5 mm (NIWA XXXX). A, right pereopod 6; B, right pereopod 7; C, operculum; D, pleopod 1; E, left pleopod 2; F, left pleopod 3; G, left pleopod 4; H, right pleopod 5; I, right uropod.

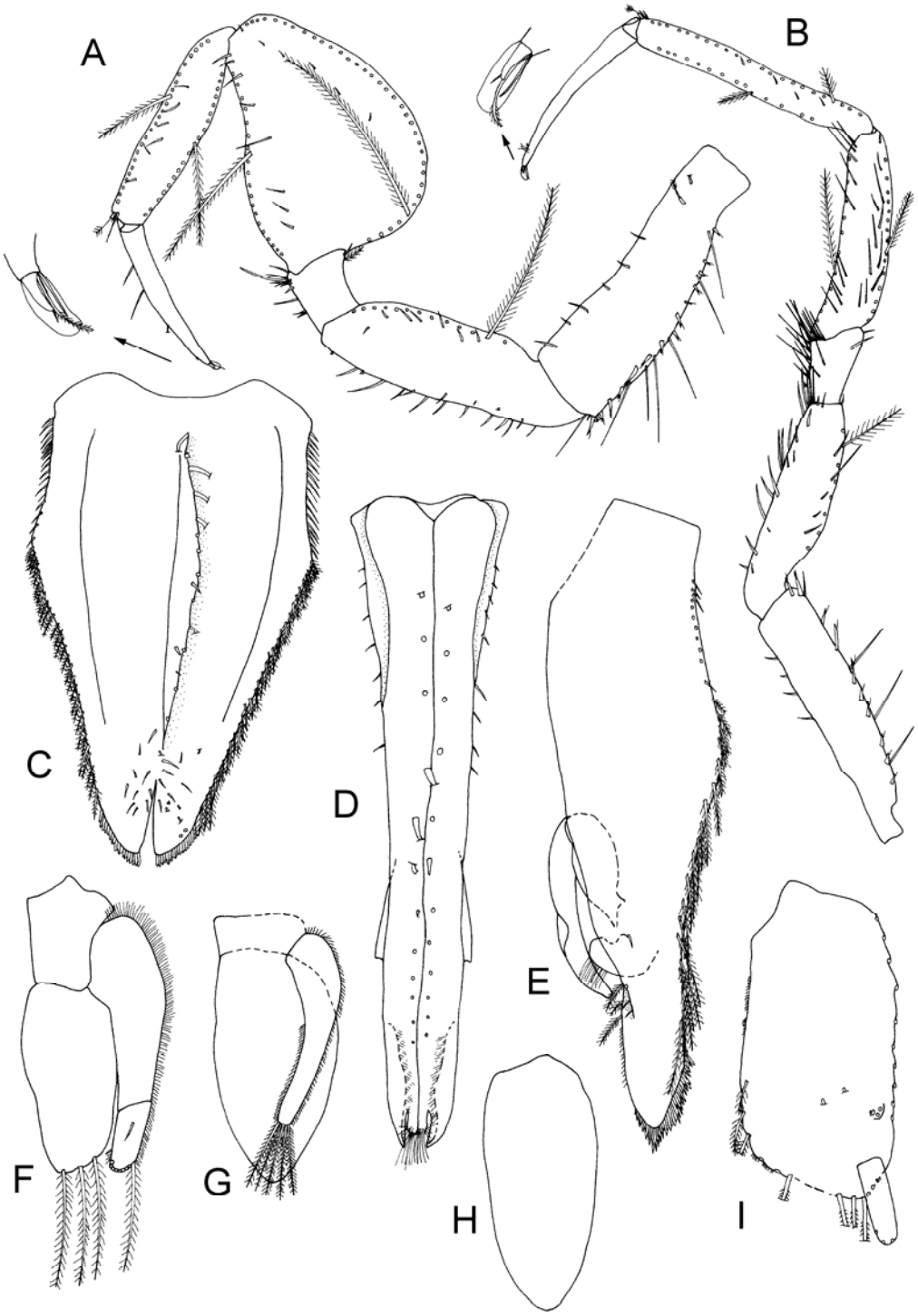
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Figure 4.37 *Ilyarachna mokari* n. sp. A–C, male holotype, 3.0 mm (NMV XXXX); D, male paratype, 3 mm (NMV XXXX); E–H, female paratype, 4.0 mm (NMV J18871). A, dorsal view; B, lateral view; C, cephalon; D, left antenna 1; E, left antenna 2; F, left antenna 1; G, left mandible; H, right mandible. Scale bar = 1 mm, for dorsal and lateral views only.

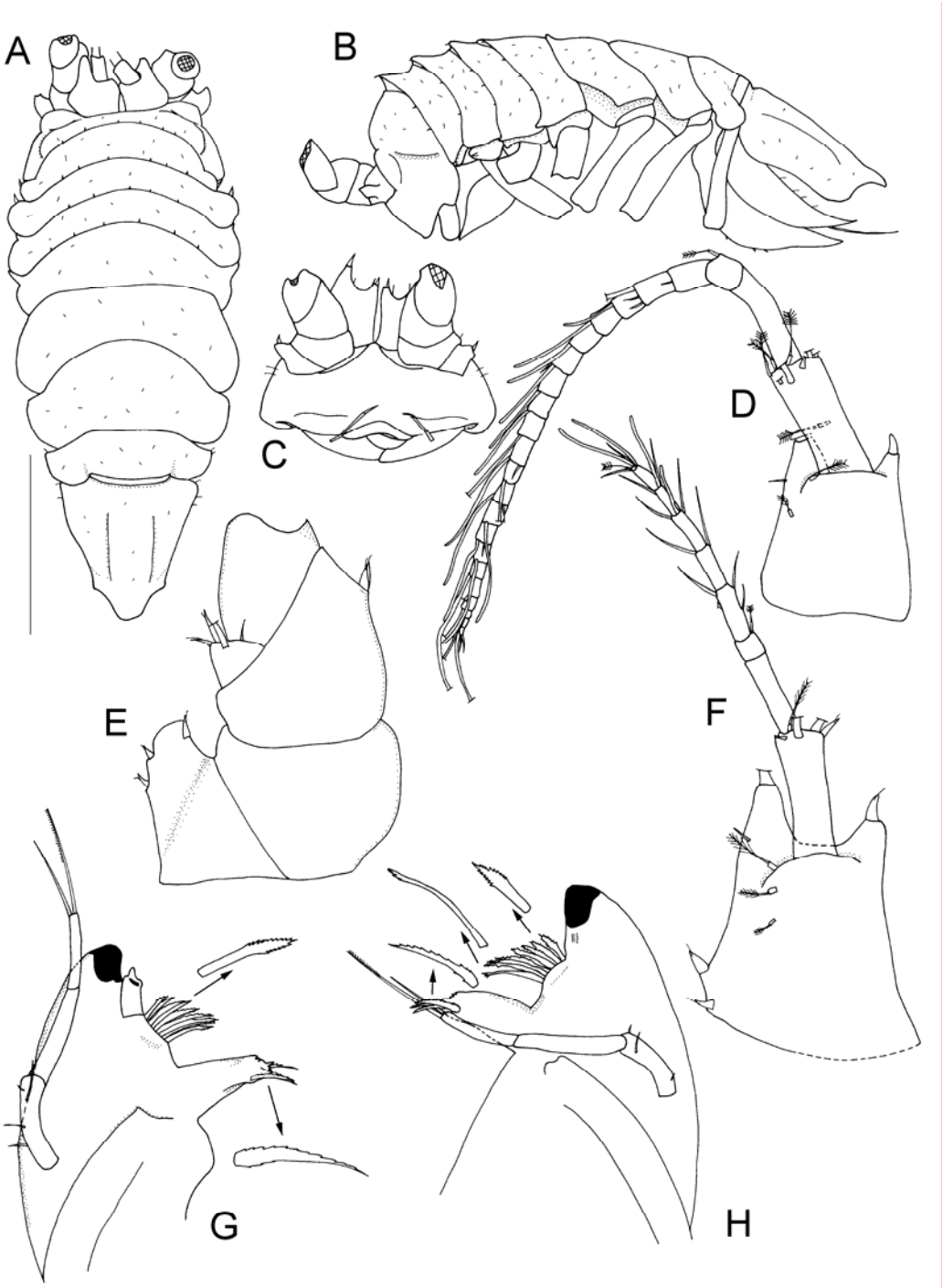
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Figure 4.38 *Ilyarachna mokari* n. sp. All figures from female paratype, 4.0 mm (NMV J18871). A, left maxilliped; B, left maxilla; C, left maxilla 2; D, right pereopod 2; E, left pereopod 1; F, right pereopod 5.

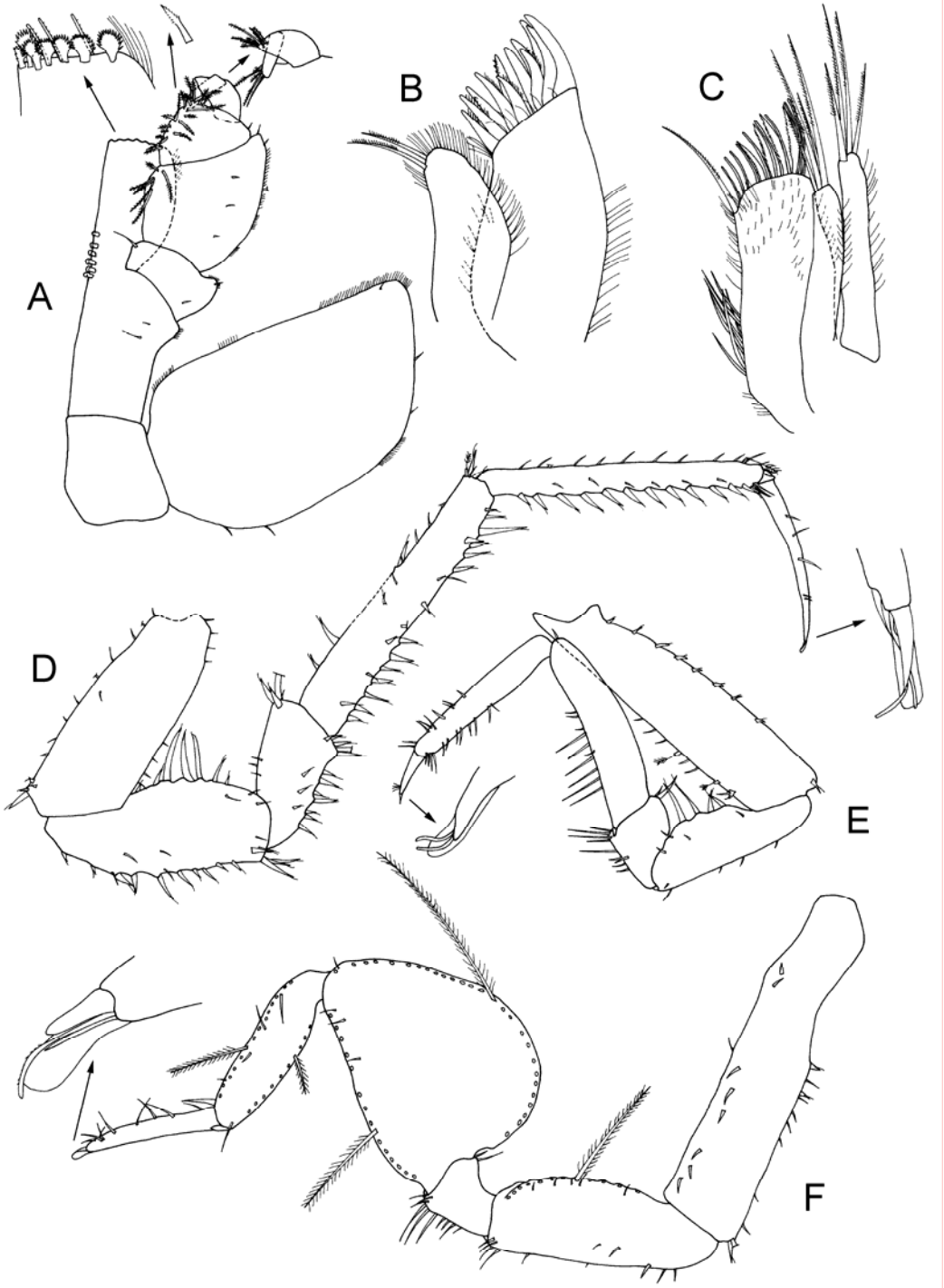
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Figure 4.39 *Ilyarachna mokari* n. sp. A, E–G, female paratype, 4.0 mm (NMV J18871); B–D, male paratype, 3.0 mm (NMV XXXX); H and I, male holotype, 3.0 mm (NMV XXXX). A, operculum; B, lateral view of pleopod 1; C, distal part of pleopod 1; D, left pleopod 2; E, left pleopod 3; F, right pleopod 4; G, right pleopod 5; H, lateral view of pereonite 7 and pleon; I, ventral view of pereonite 7.

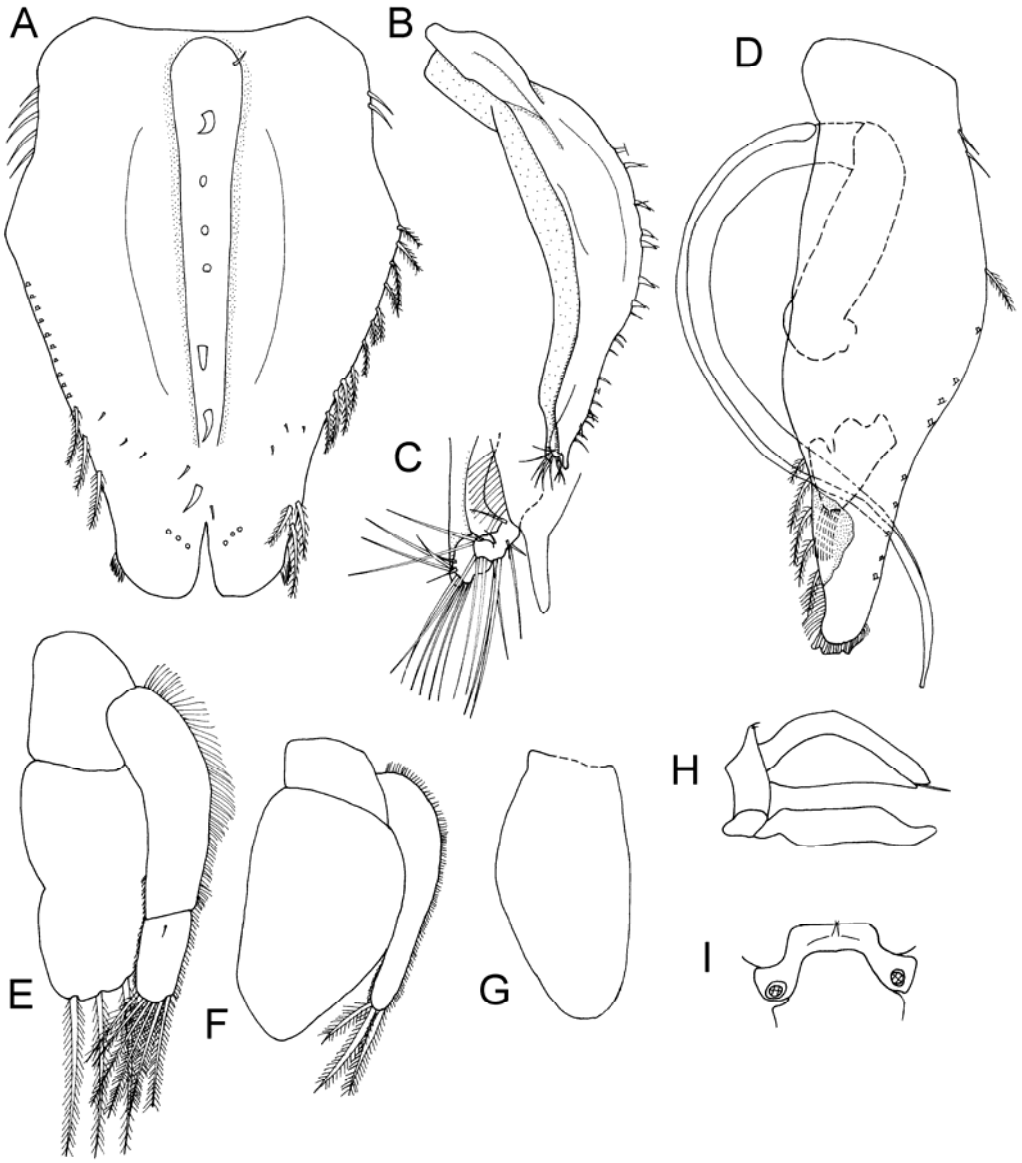
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Figure 4.40 *Ilyarachna pacifica* n. sp. A–C, E male holotype, 6.0 mm (NIWA XXXX); D, male paratype, 4.0 mm (posterior half only) (NIWA XXXX); F, H–N male paratype, 3.5 mm (anterior half only) (NIWA XXXX); G, female paratype, 5 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, ventral view of pereonite 7 and pleon; E, dorsal view of pleon; F, left antenna 2; G, right antenna 1; H, left antenna 1; I, left mandible; J, spine row of left mandible; K, molar of left mandible; L, right mandible; M, spine row of right mandible; N, molar of right mandible. Scale bar = 1 mm, for dorsal and lateral views only.

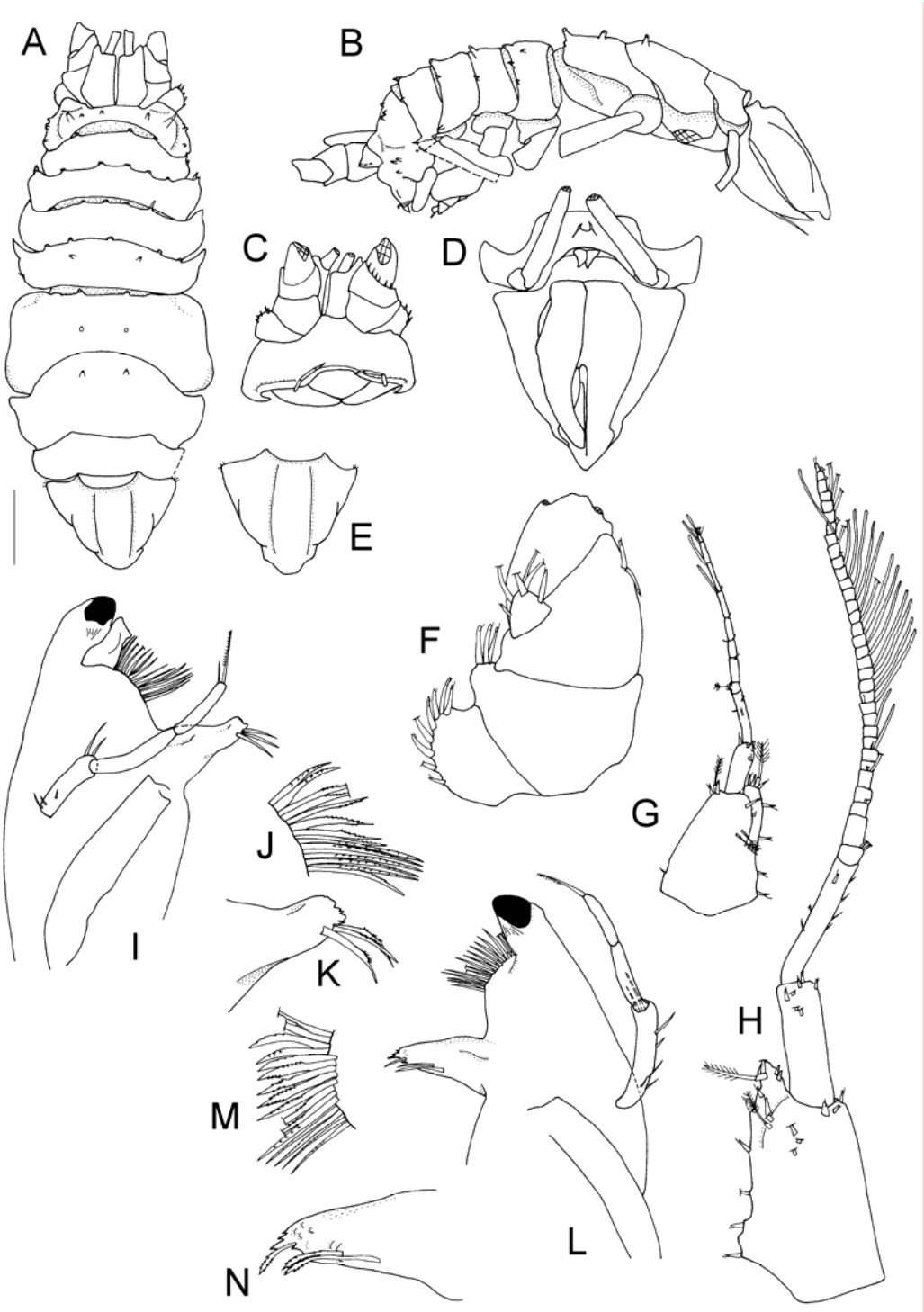
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Figure 4.41 *Ilyarachna pacifica* n. sp. A–D, male paratype, 3.5 mm (anterior half only) (NIWA XXXX); E, female paratype, 5.0 mm (NIWA XXXX); F–G, male paratype, 4.0 mm (posterior half only) (NIWA XXXX). A, left maxilla 1; B, left maxilla 2; C, left maxilliped; D, endite of left maxilliped; E, operculum; F, pleopod 1; G, left pleopod 2.

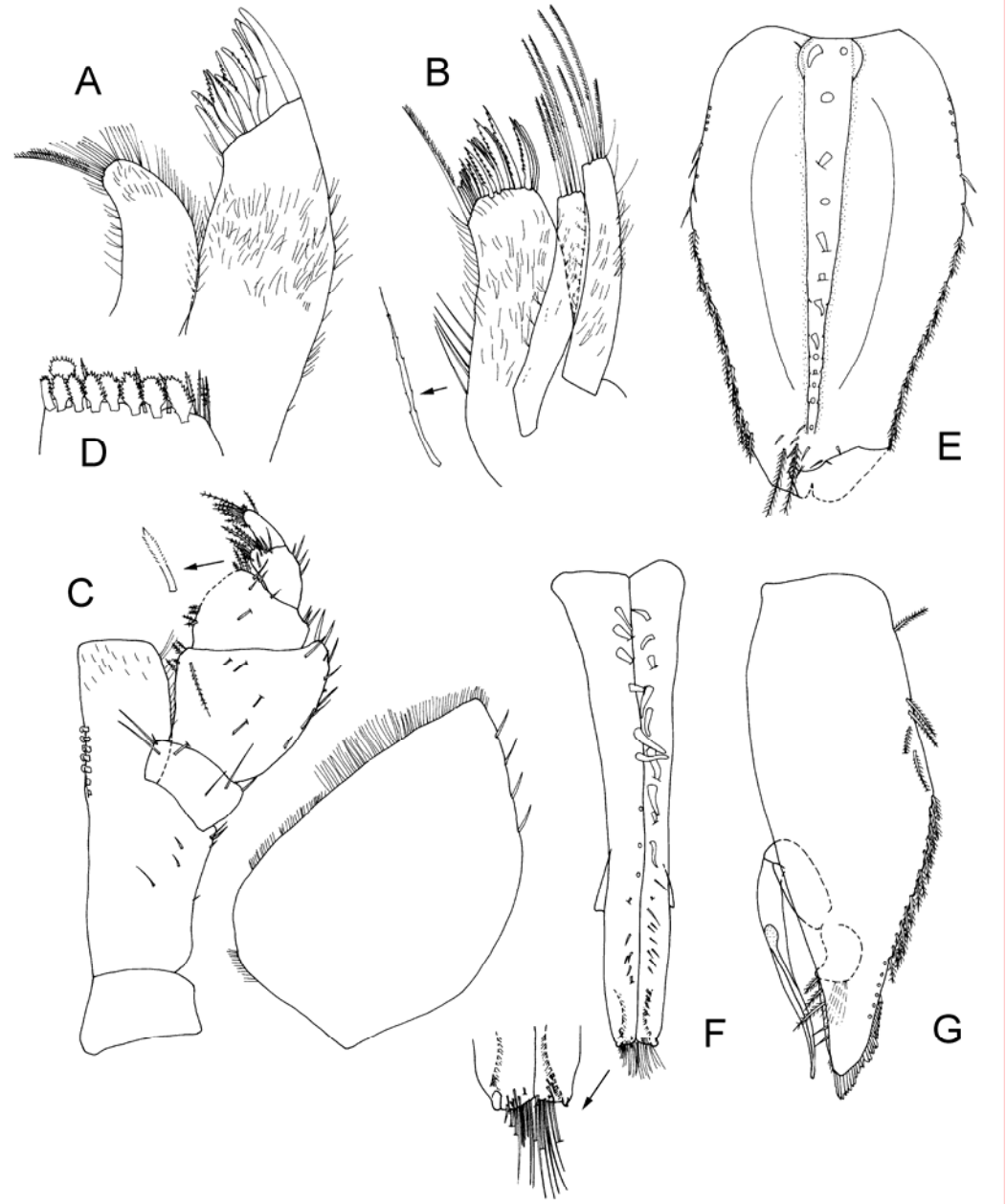
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Figure 4.42 *Ilyarachna pacifica* n. sp. All figures from male paratype, 4.0 mm (posterior half only) (NIWA XXXX). A, left pleopod 3; B, left pleopod 4; C, left pleopod 5; D, right uropod.

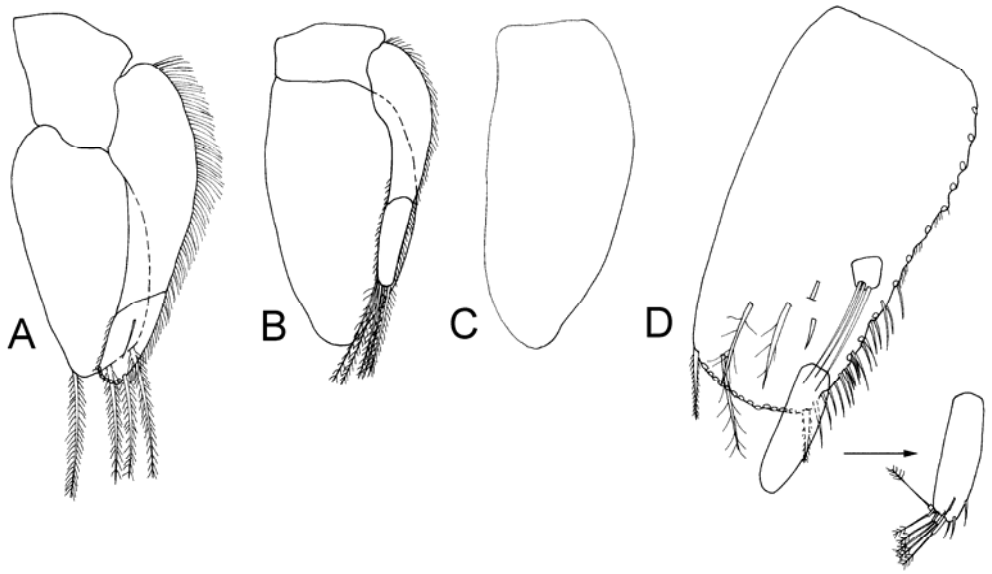
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Figure 4.43 *Ilyarachna quorna* n. sp. A–D , G, female holotype, 4.4 mm (NMV XXXX); E, F, H, I, male paratype, 4.0 mm (NMV XXXX). A, dorsal view; B, lateral view; C, cephalon; D, ventral view of pereonites 6 and 7; E, left antenna 2; F, right antenna 1; G, left antenna 1; H, left mandible; I, right mandible. Scale bar = 1 mm, for dorsal and lateral views only.

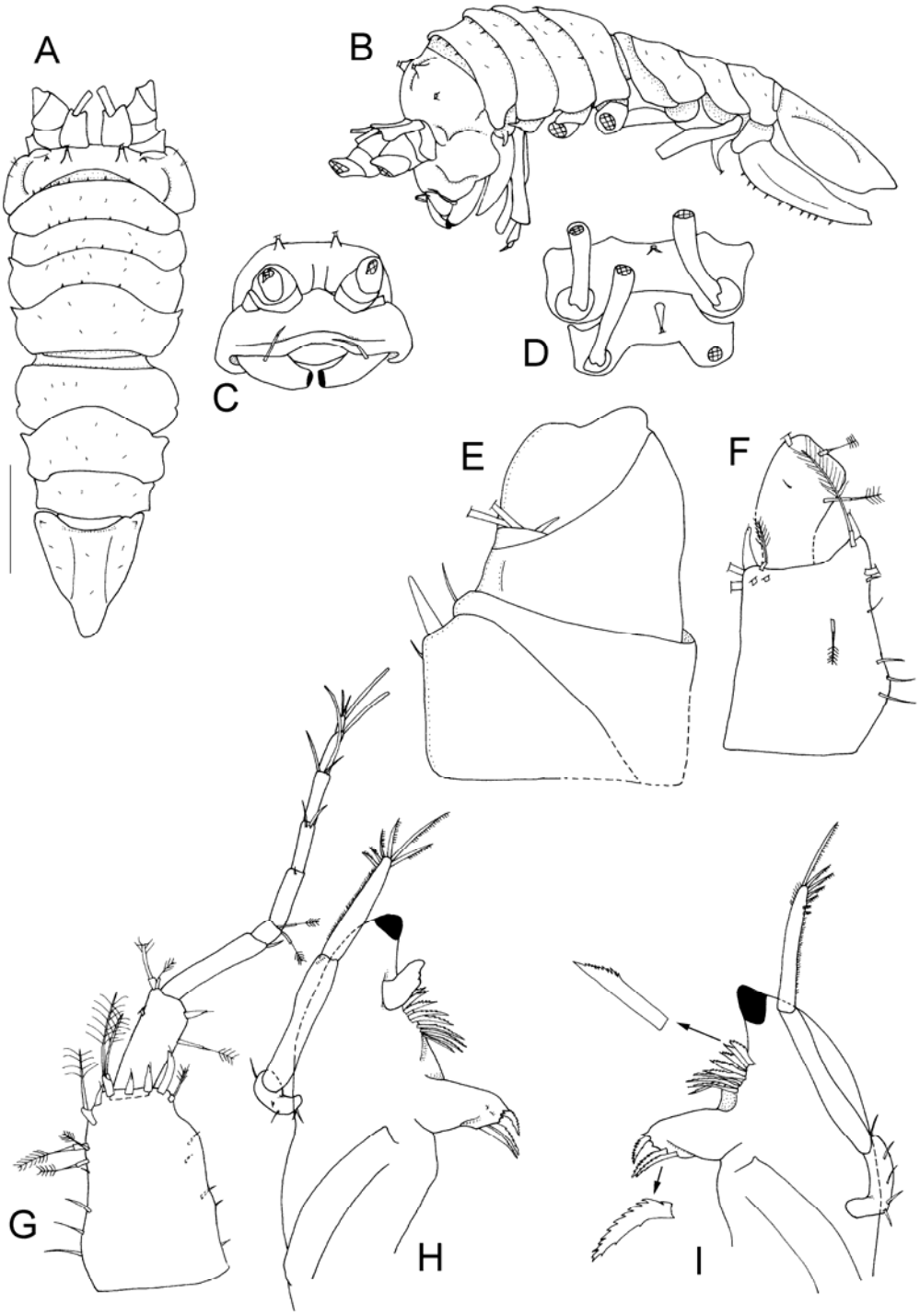
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Figure 4.44 *Ilyarachna quorna* n. sp. All figures from male paratype, 4 mm (NMV XXXX). A, left maxilla 1; B, left maxilla 2; C, lateral view of pleopod 1; D, left maxilliped; E, right pereopod 1; F, left pleopod 2.

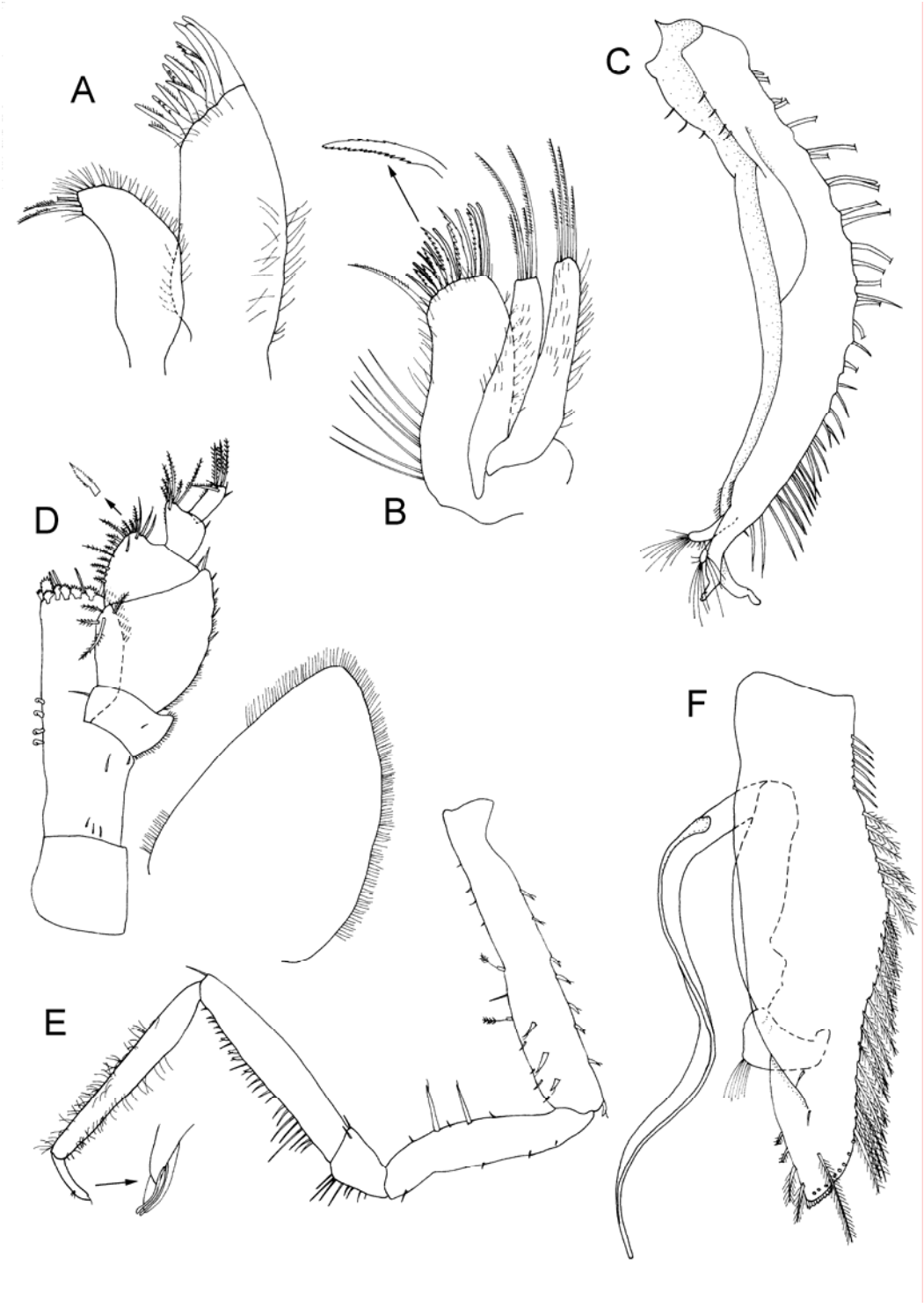
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Figure 4.45 *Ilyarachna quorna* n. sp. A, female holotype, 4.4 mm (NMV XXXX); B–D, male paratype, 4 mm (NMV XXXX). A, operculum; B, left pleopod 3; C, left pleopod 4; D, left pleopod 5.

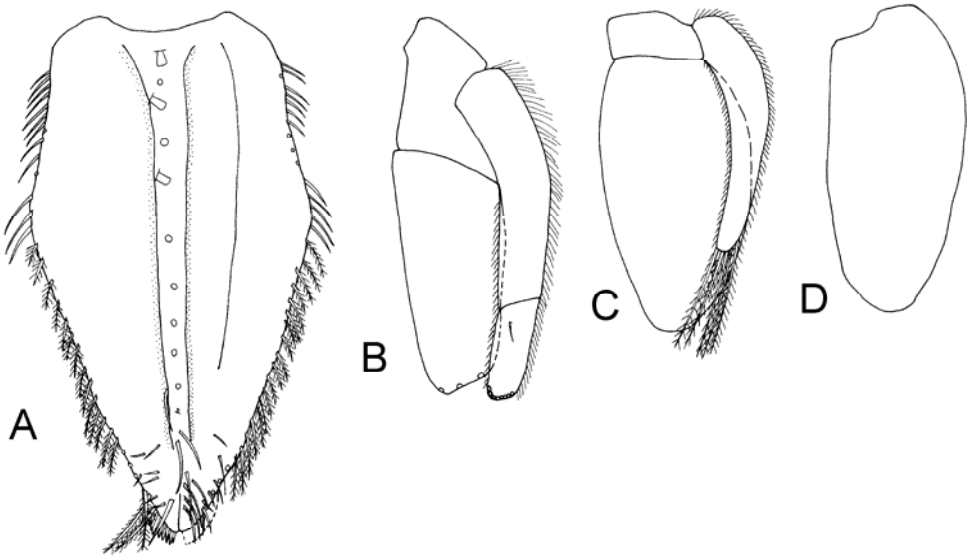
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Figure 4.46 *Ilyarachna taranui* n. sp. A–D, male holotype, 4.0 mm (NIWA XXXX); E–H, male paratype, 4 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, ventral view of pleon and pereonite 7; E, right antenna 2; F, right antenna 1; G, left mandible; H, right mandible. Scale bar = 1 mm, for dorsal and lateral views only.

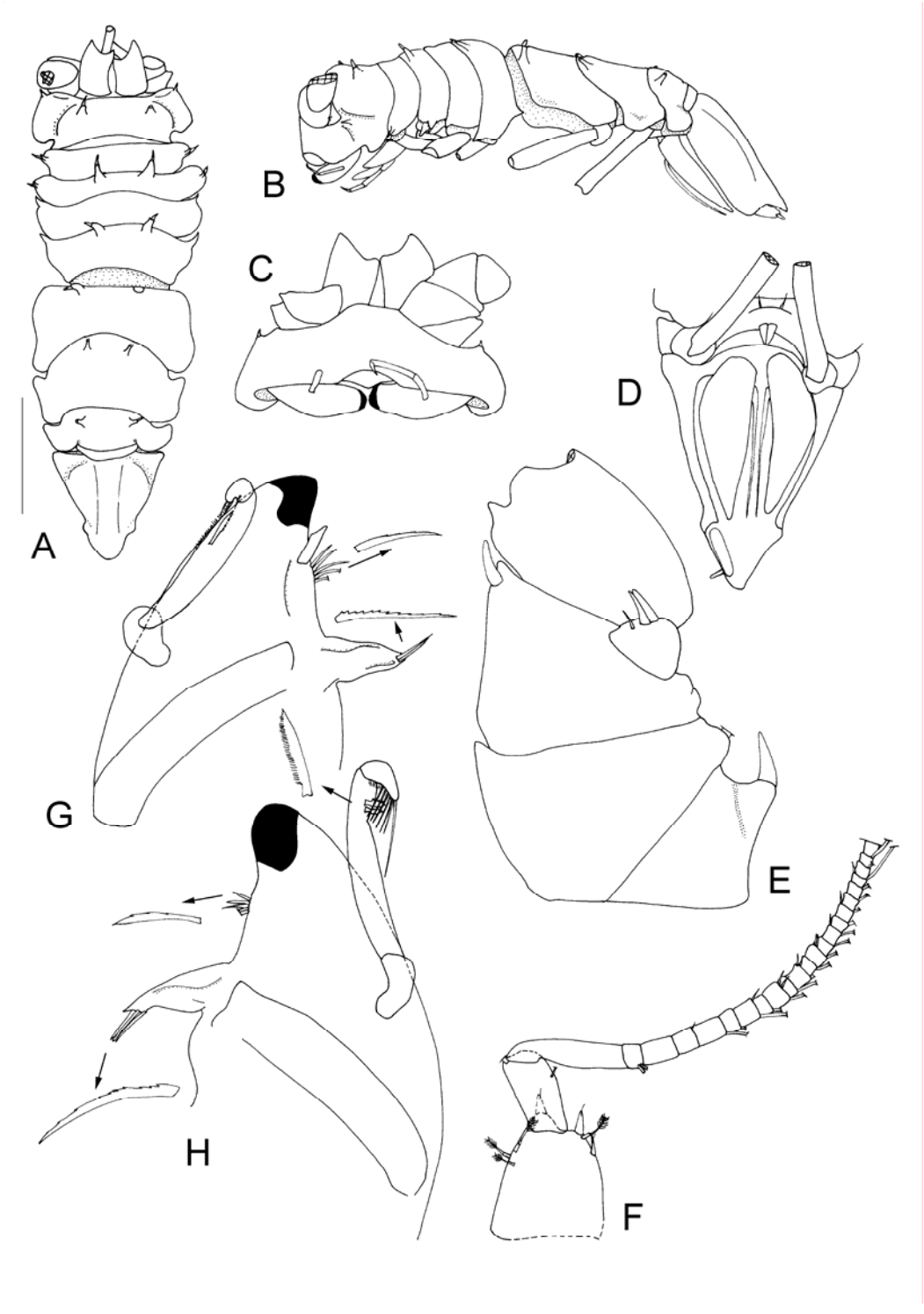
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Figure 4.47 *Ilyarachna taranui* n. sp. All figures from male paratype, 4.0 mm (NIWA XXXX). A, left maxilliped; B, distal end of left maxilliped endite; C, right maxilla 1; D, right maxilla 2; E, lateral view of pleopod 1; F, left pleopod 2; G, left pleopod 5; H, left uropod; I, endopod of left uropod.

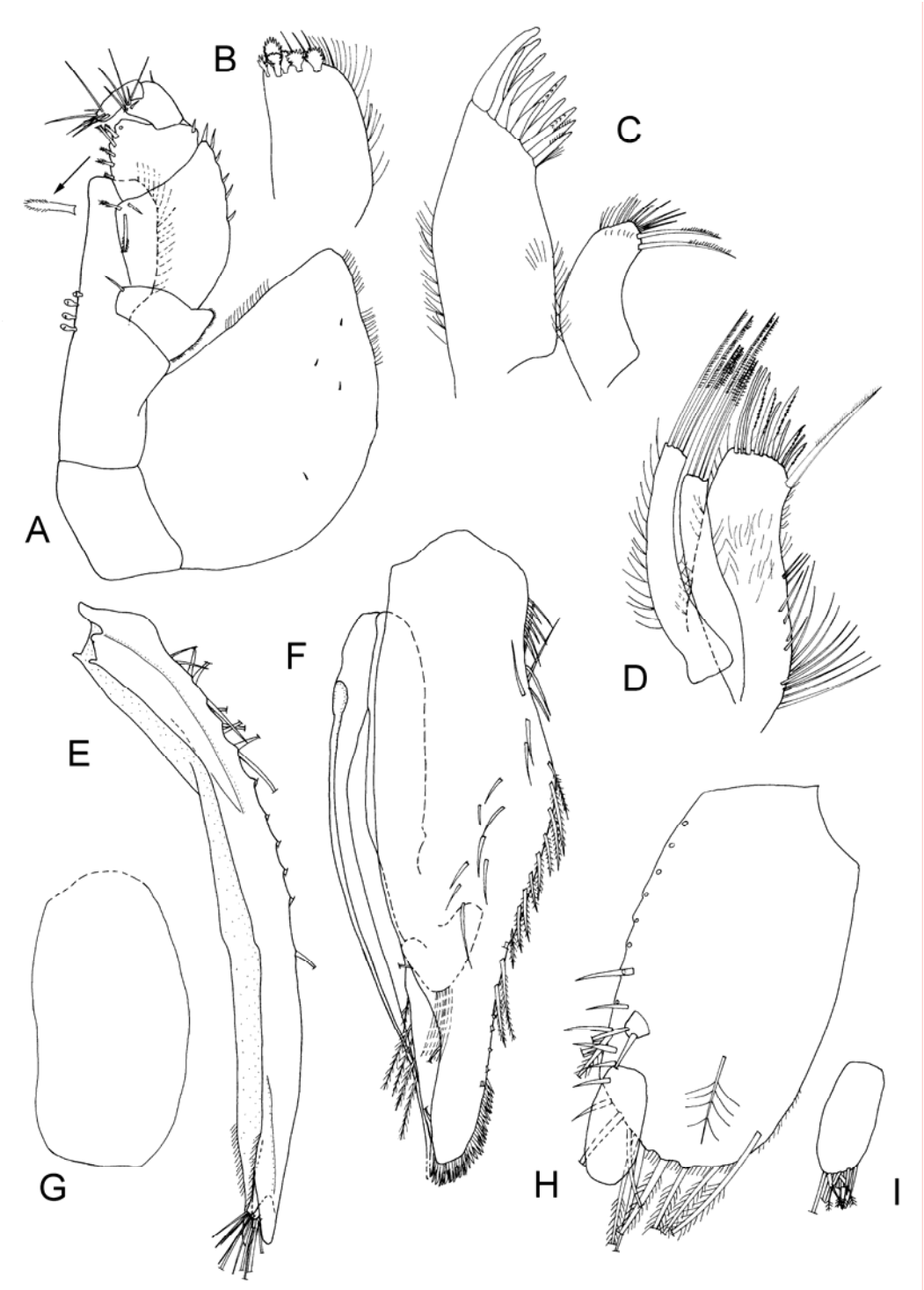
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Figure 4.48 *Ilyarachna taratara* n. sp. A–C, male holotype, 6.0 mm (NIWA XXXX); D–I, female paratype, 6.0 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, left antenna 1; E, left antenna 2; F, spine row of left mandible; G, left mandible; H, right mandible; I, spine row of right mandible. Scale bar = 1 mm, for dorsal and lateral views only.

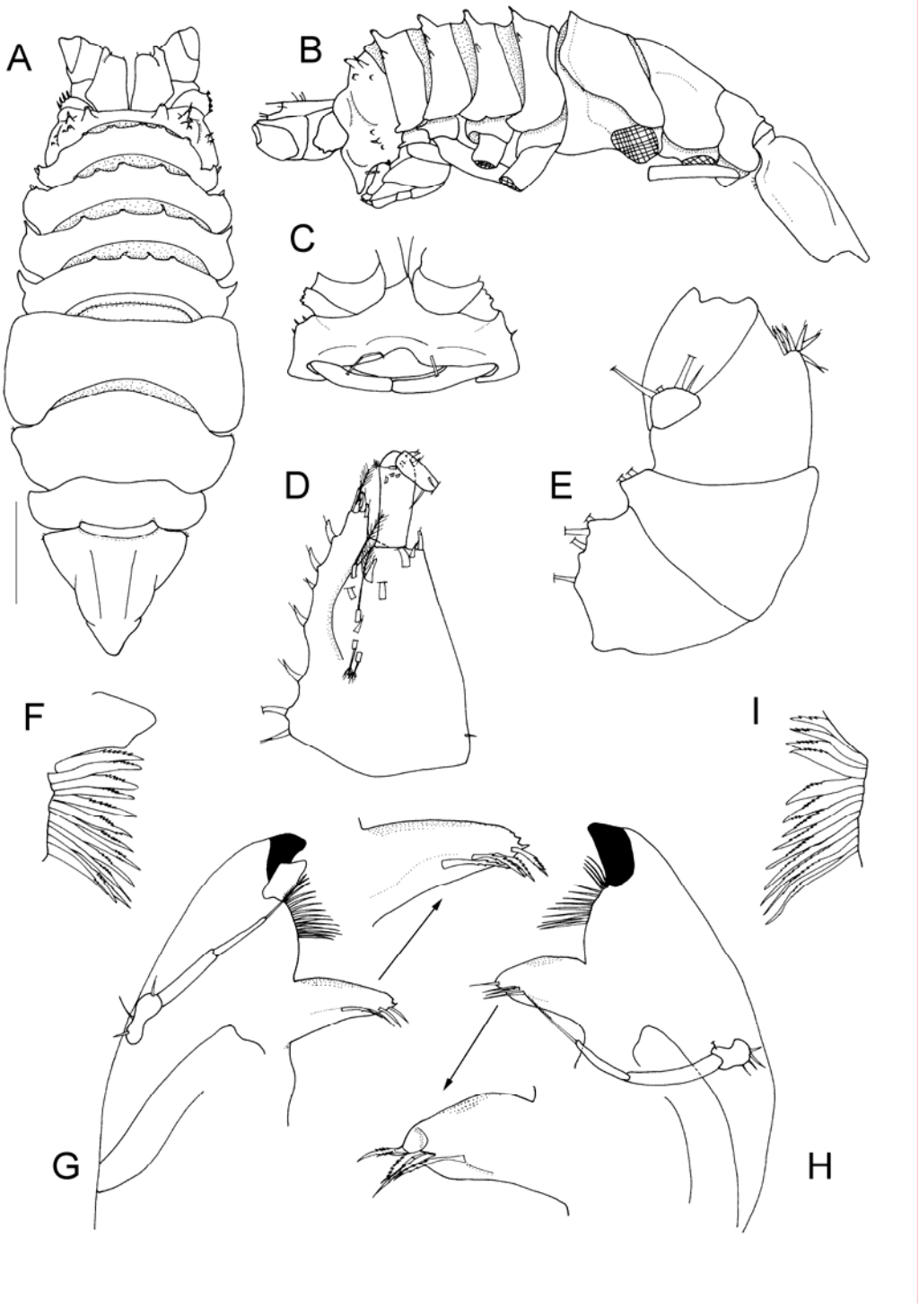
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Figure 4.49 *Ilyarachna taratara* n. sp. A–E, female paratype, 6.5 mm (NIWA XXXX); F, male paratype, 5 mm (telson missing; NIWA XXXX). A, left maxilla 1; B, left maxilla 2; C, left maxilliped; D, left pleopod 1; E, operculum; F, ventral view of pereonite 7.

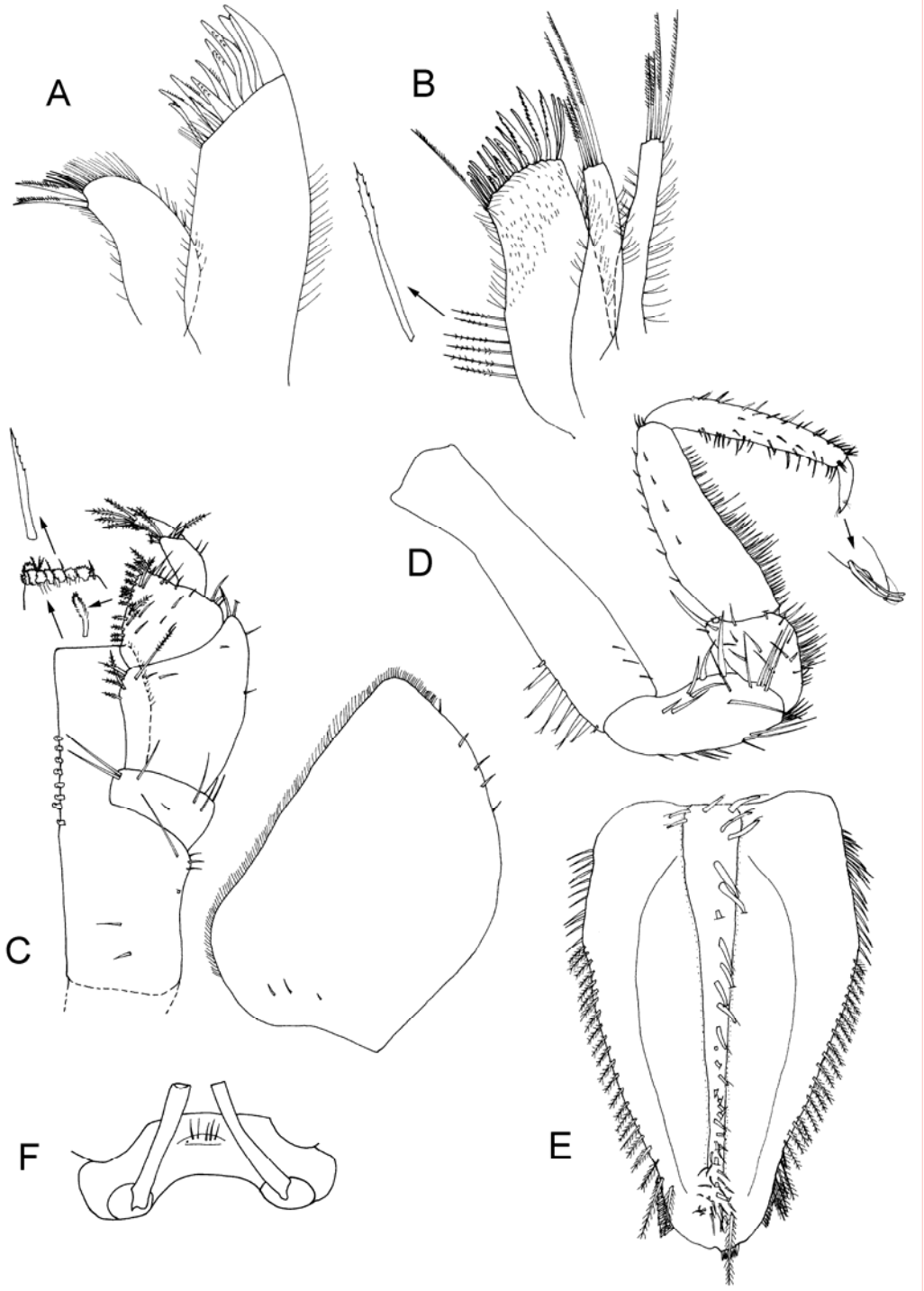
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Figure 4.50 *Ilyarachna taratara* n. sp. A, B, male holotype, 6 mm (NIWA XXXX); C–F, female paratype, 6.5 mm (NIWA XXXX). A, pleopod 1; B, left pleopod 2; C, left pleopod 3; D, left pleopod 4; E, left pleopod 5; F, left uropod.

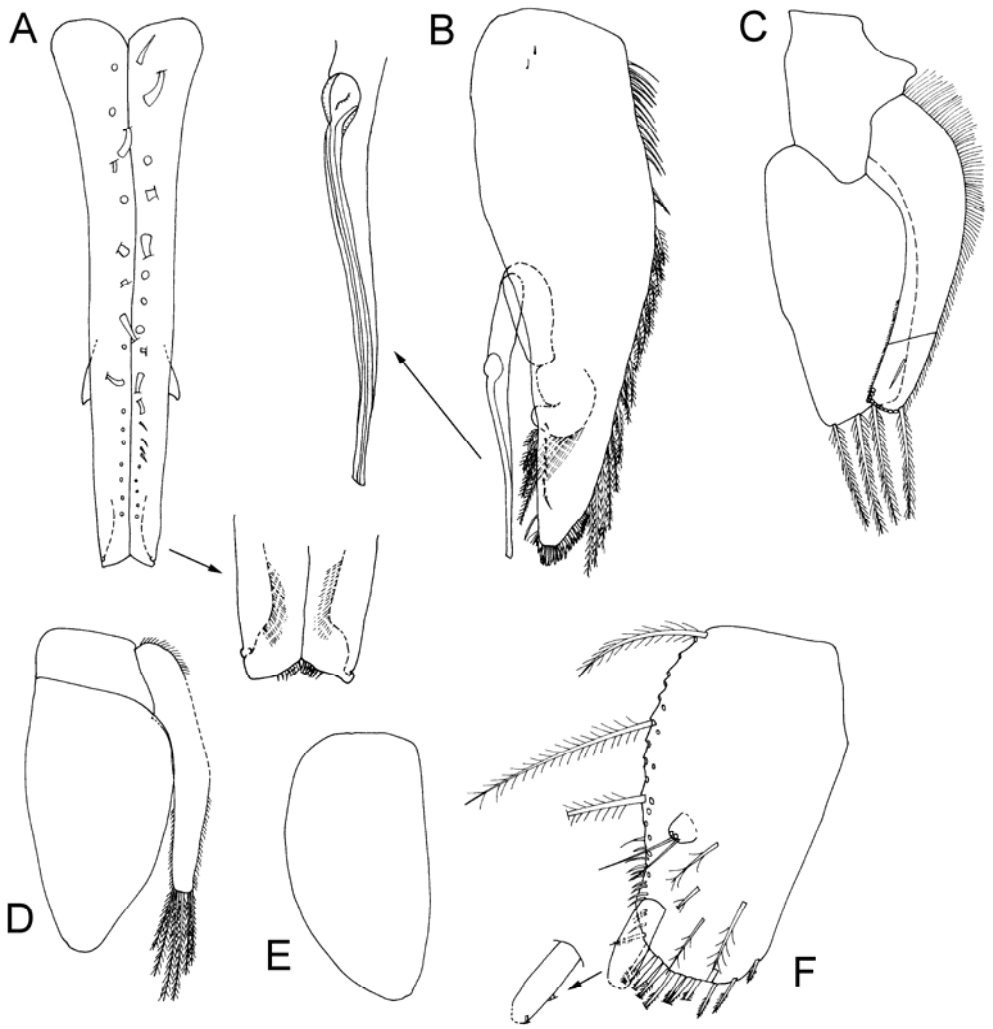
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Figure 4.51 *Notopais beddardi* Merrin, 2004b. All figures from female holotype, 4.0 mm (BMNH 2004.677). A, dorsal view; B, lateral view; C, left antenna 1 and 2, dorsal view; D, left antenna 2, ventral view; E, right pereopod 2; F, operculum. Scale bar = 1 mm, for dorsal and lateral views only.

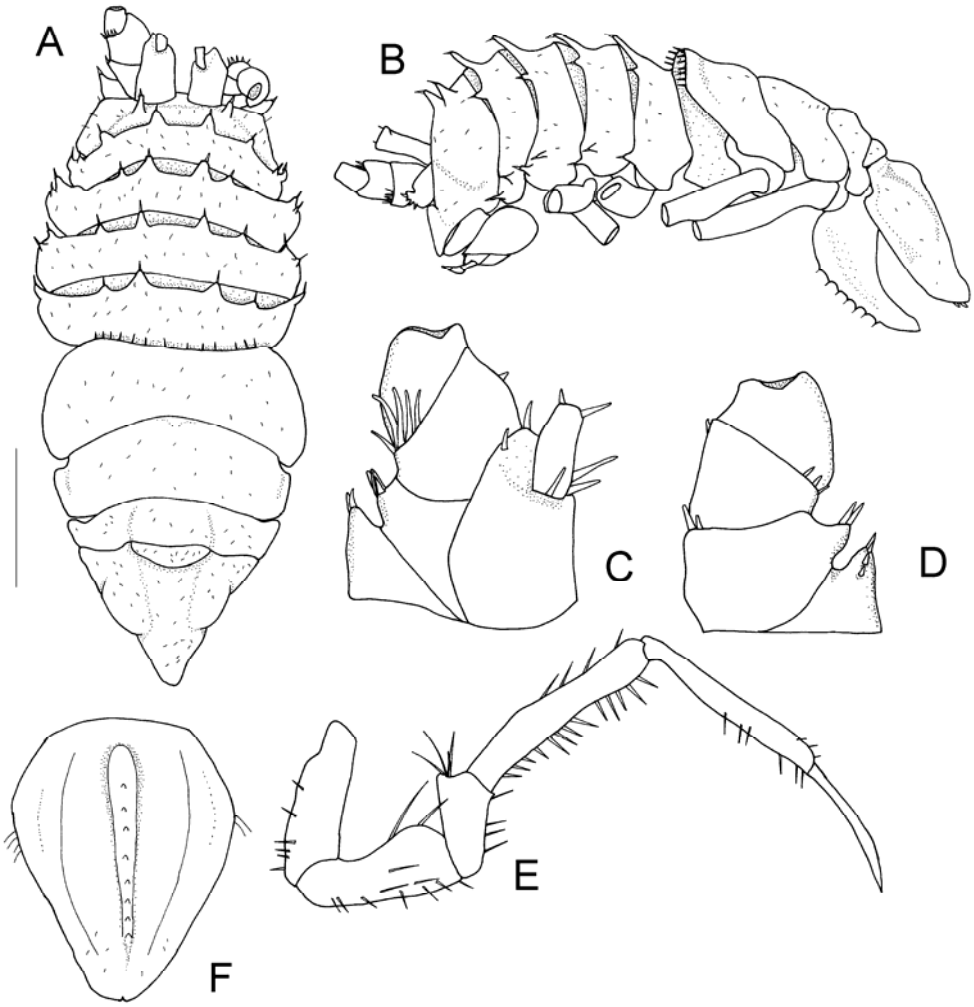
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Figure 4.52 *Notopais chathamensis* n. sp. A–C, H, female holotype, 4.0 mm (NIWA XXXX); D, male paratype, 3.5 mm (NIWA XXXX); E–G, I, female paratype, 3.0 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, right antenna 1; E, left antenna 1; F, left antenna 2; G, left mandible; H, ventral view of pleon and pereonite 7; I, left maxilla 1. Scale bar = 1 mm, for dorsal and lateral views only.

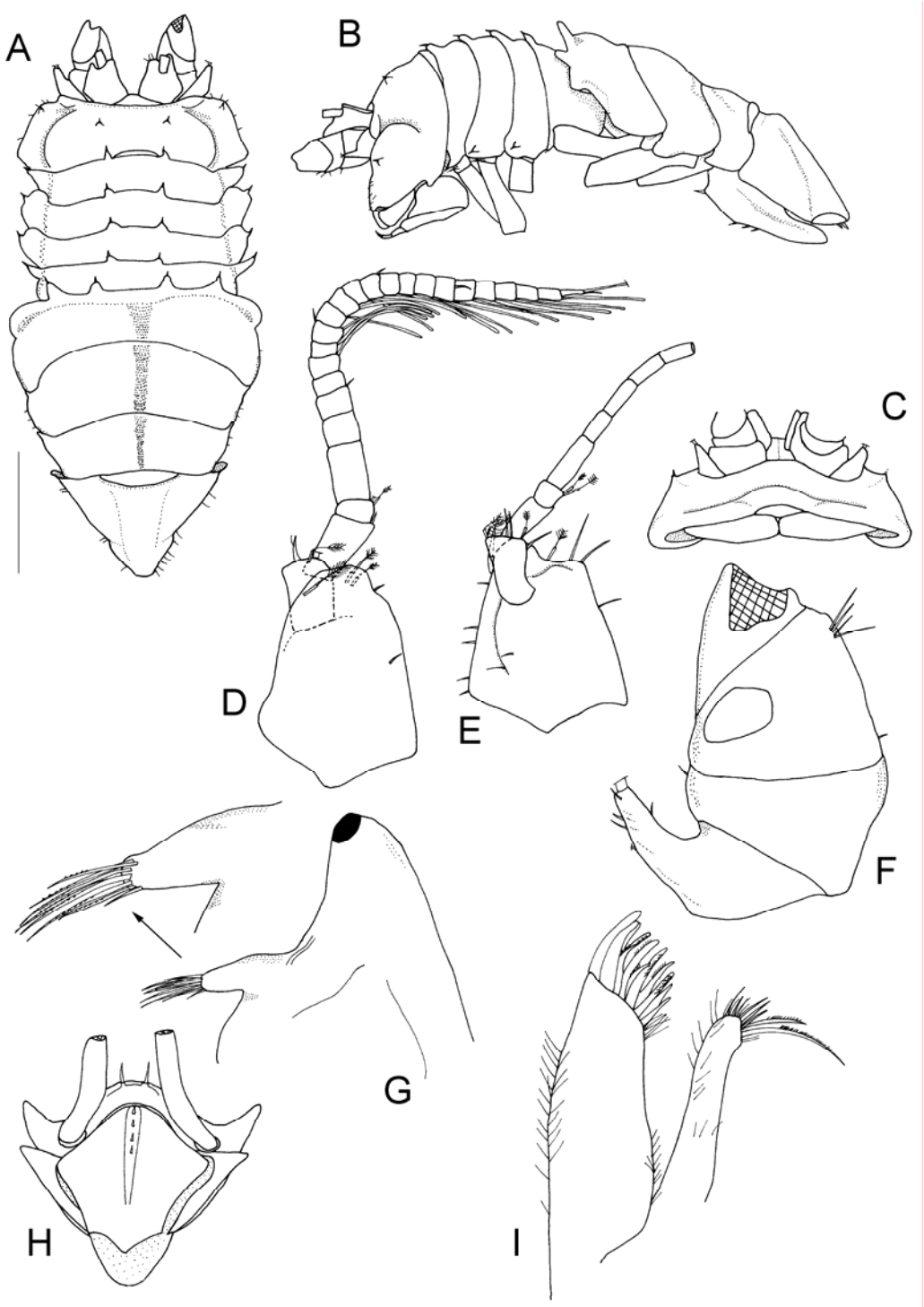
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Figure 4.53 *Notopais chathamensis* n. sp. A–G, I, female paratype, 3.0 mm (NIWA XXXX); G, H, J, male paratype 3.5 mm (NIWA XXXX). A, left maxilla 1; B, left maxilliped; C, distal part of left maxilliped endite; D, right pereopod 1; E, unguis of right pereopod 1; F, left pereopod 5; G, distal ends (illustrated separately) of pleopod 1; H, pleopod 1; I, right pereopod 7; J, left pleopod 2.

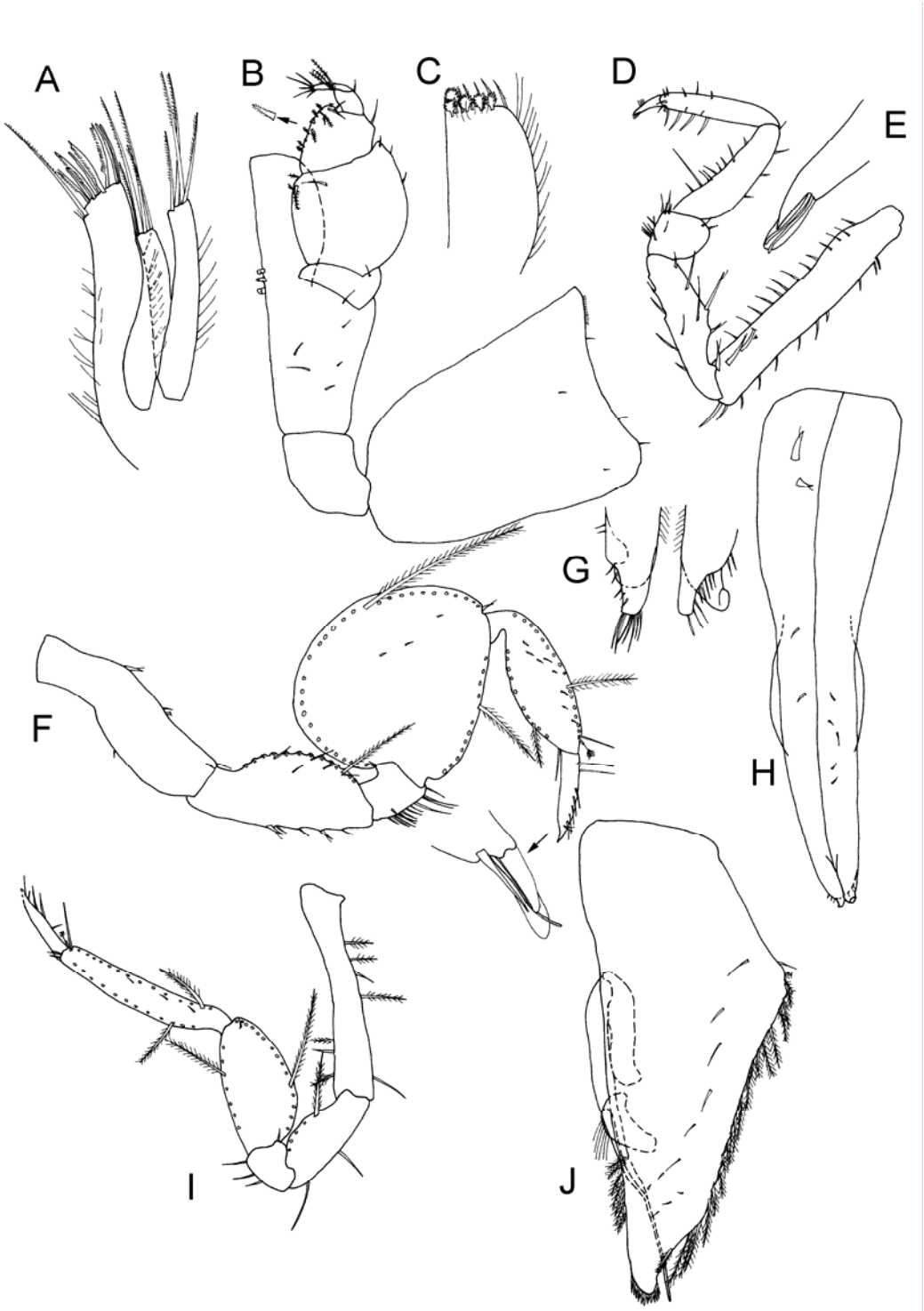
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Figure 4.54 *Notopais chathamensis* n. sp. All figures from female paratype, 3.0 mm (NIWA XXXX). A, operculum; B, left pleopod 3; C, left pleopod 4; D, right pleopod 5; E, left uropod.

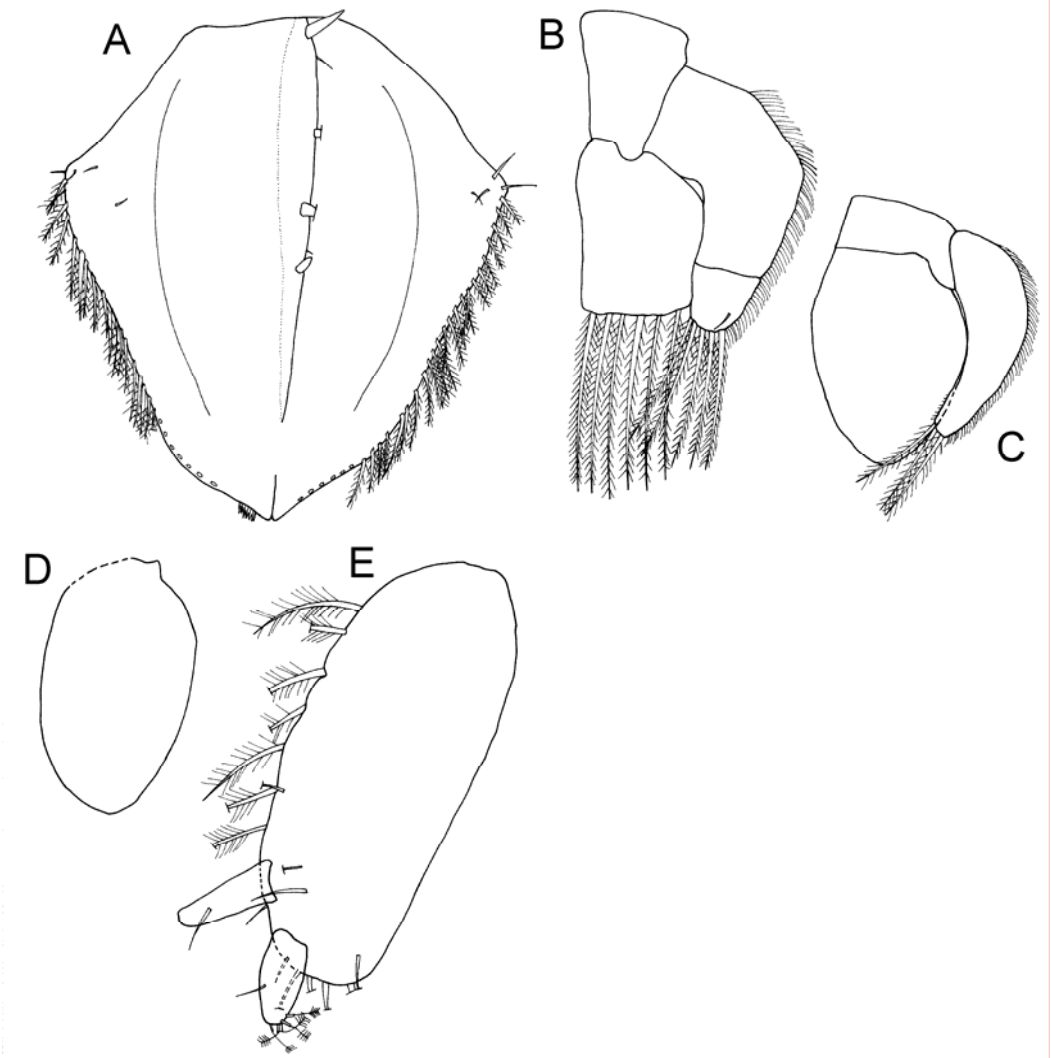
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Figure 4.55 *Notopais echinatus* n. sp. A, B, G, female holotype, 8.5 mm (AM XXXX); D, F, H, female paratype, 8.0 mm (AM XXXX); C, E, male paratype, 7.0 mm (AM XXXX). A, dorsal view; B, lateral view; C, right antenna 1; D, left antenna 1; E, right antenna 2; F, right mandible; G, cephalon; H, left maxilla 1. Scale bar = 1 mm, for dorsal and lateral views only.

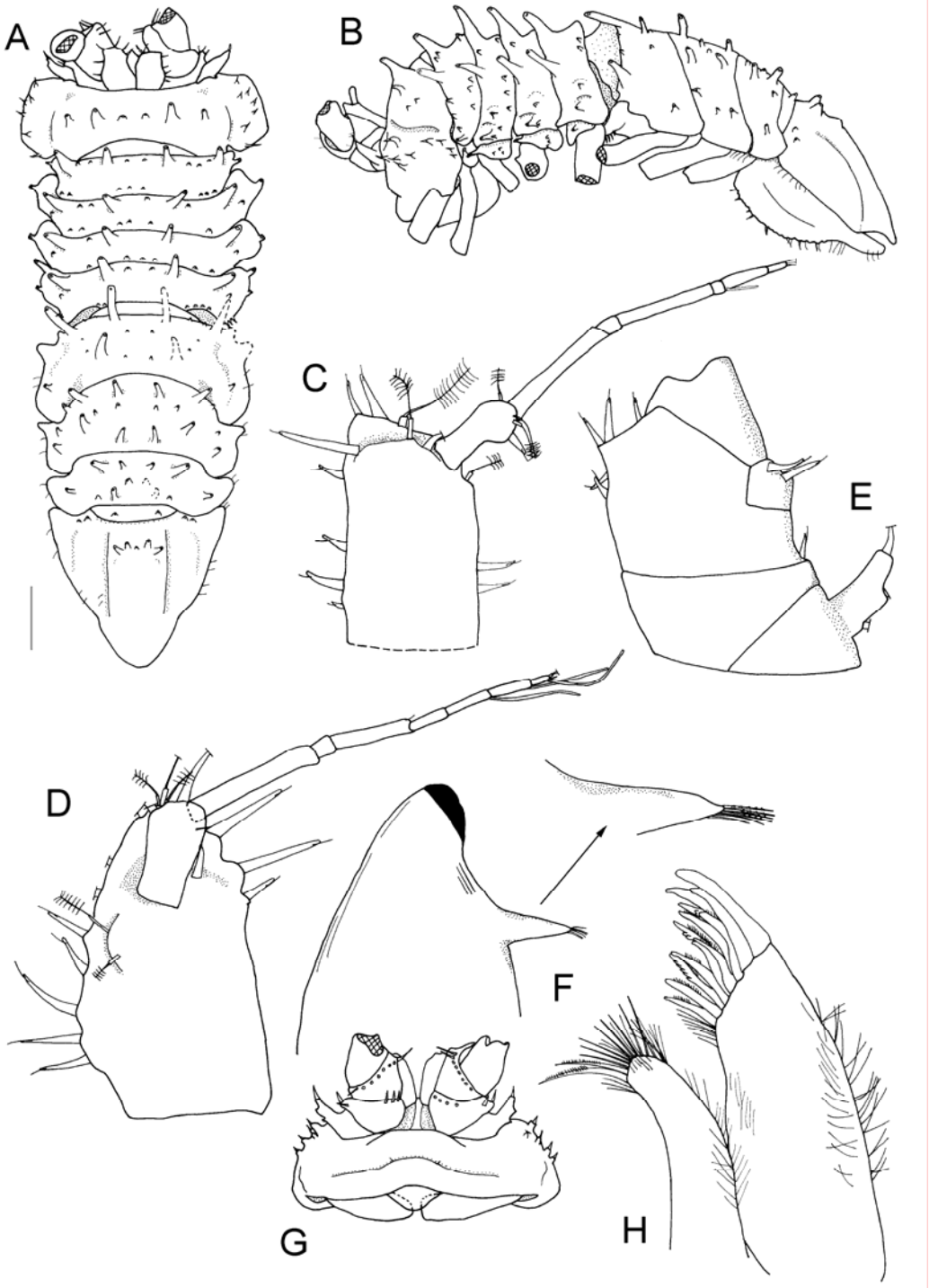
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Figure 4.56 *Notopais echinatus* n. sp. A–D, female paratype, 8.0 mm (AM XXXX); E–G, from second female paratype, 6.0 mm (AM XXXX). A, left maxilla 2; B, left maxilliped; C, left mandible; D, left mandibular molar; E, right pereopod 1; F, left pereopod 6; G, left pereopod 2.

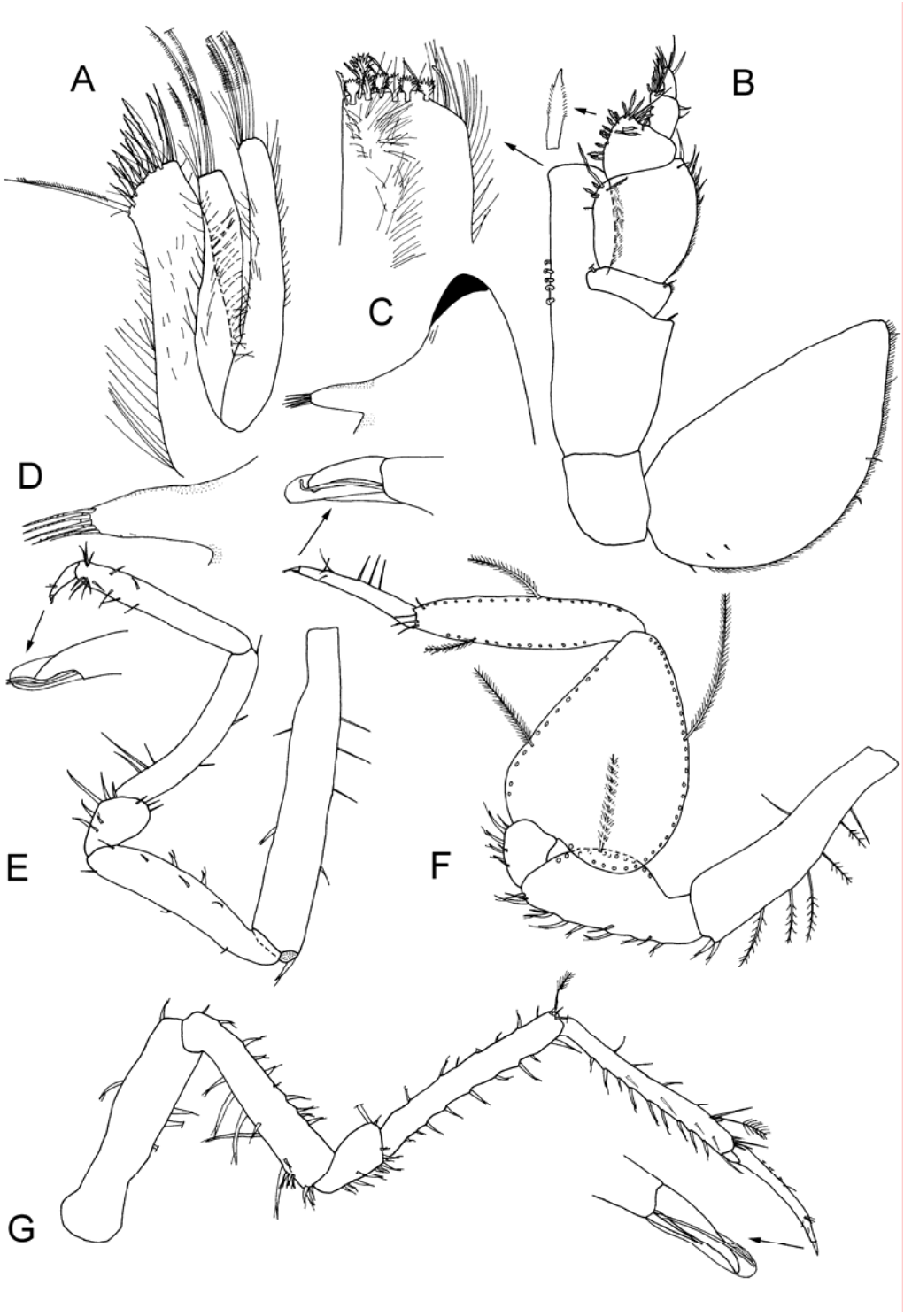
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Figure 4.57 *Notopais echinatus* n. sp. A, B, male paratype, 7.0 mm (AM XXXX); C–H, female paratype, 8.0 mm (AM XXXX); I, female holotype, 8.5 mm (AM XXXX). A, pleopod 1; B, left pleopod 2; C, operculum; D, left pleopod 3; E, left pleopod 4; F, right pleopod 5; G, left uropod; H, endopod and exopod of left uropod; I, ventral view of pereonites 6 and 7.

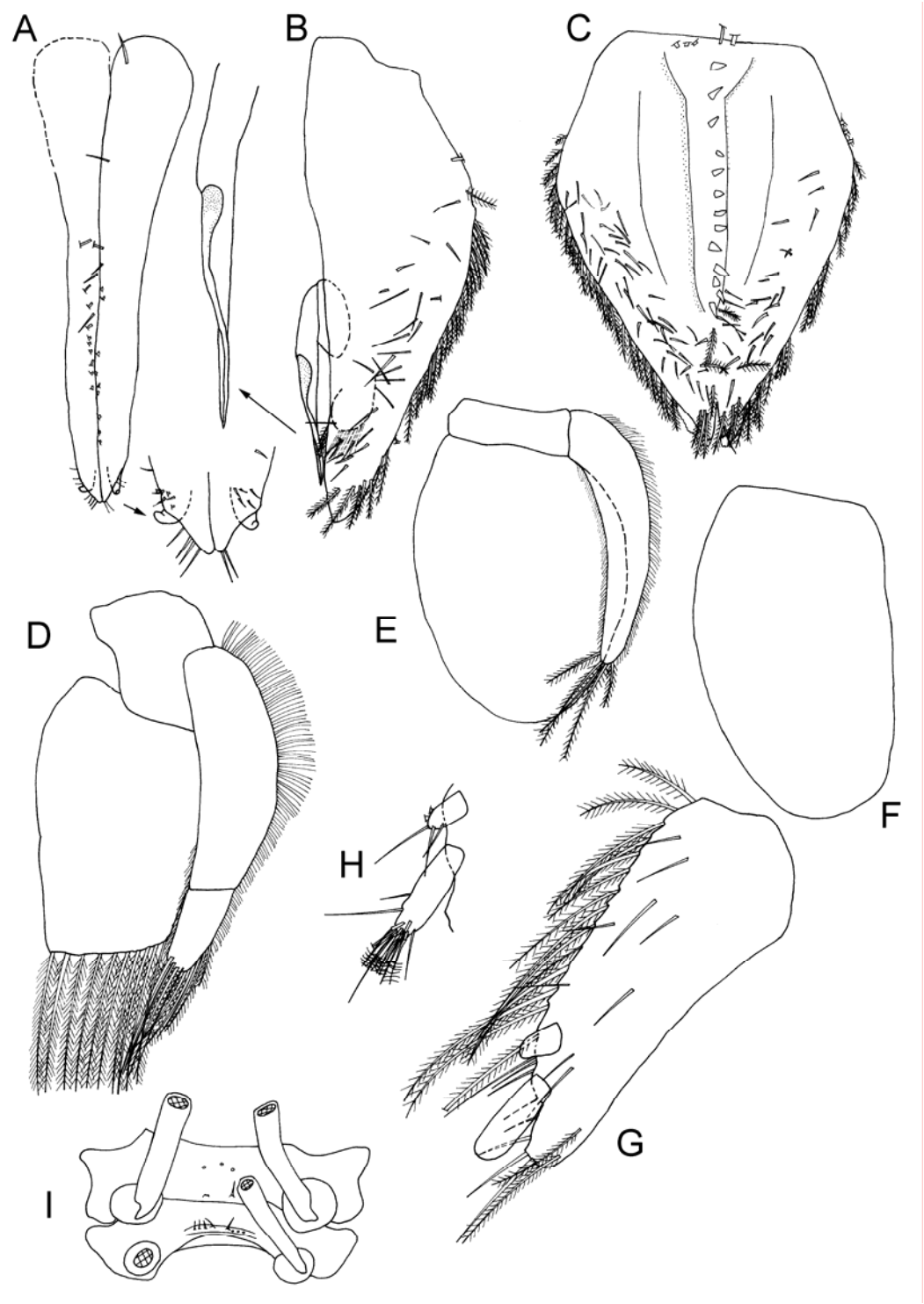
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Figure 4.58 *Notopais euaxos* n. sp. A–C**,** female holotype, 8.5 mm (NIWA XXXX); D–I, female paratype, 12.5 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, left antenna 1; E, right antenna 2; F, left mandible; G, molar of left mandible; H, left maxilla 1; I, left maxilla 2. Scale bar = 1 mm, for dorsal and lateral views only.

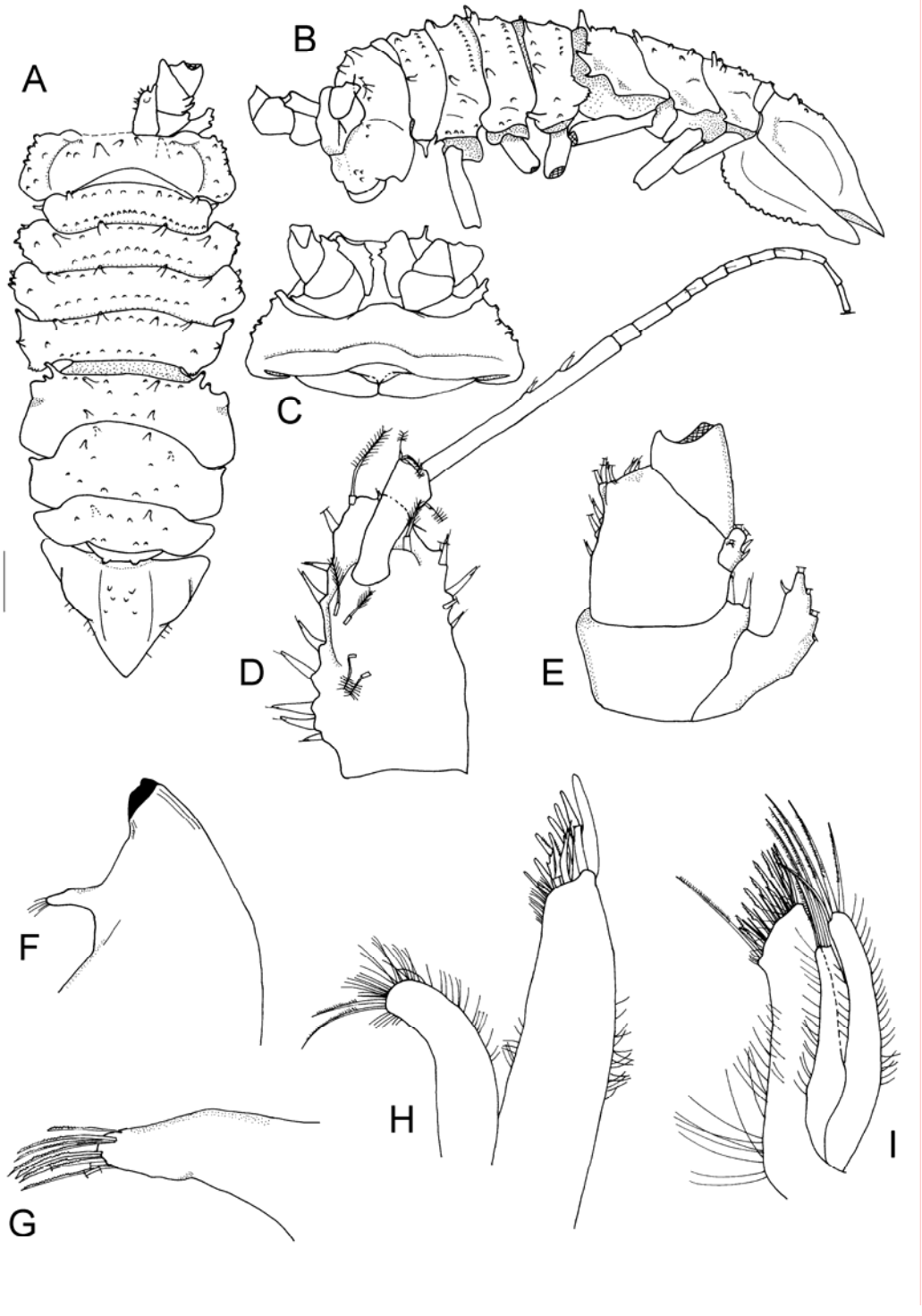
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Figure 4.59 *Notopais euaxos* n. sp. A, D–G, female paratype, 12.5 mm (NIWA XXXX); B, C, H, female holotype, 8.5 mm (NIWA XXXX). A, left maxilliped; B, right pereopod 1; C, operculum; D, left pleopod 3; E, left pleopod 4; F, left pleopod 5; G, left uropod; H, ventral view of pereonite 7.

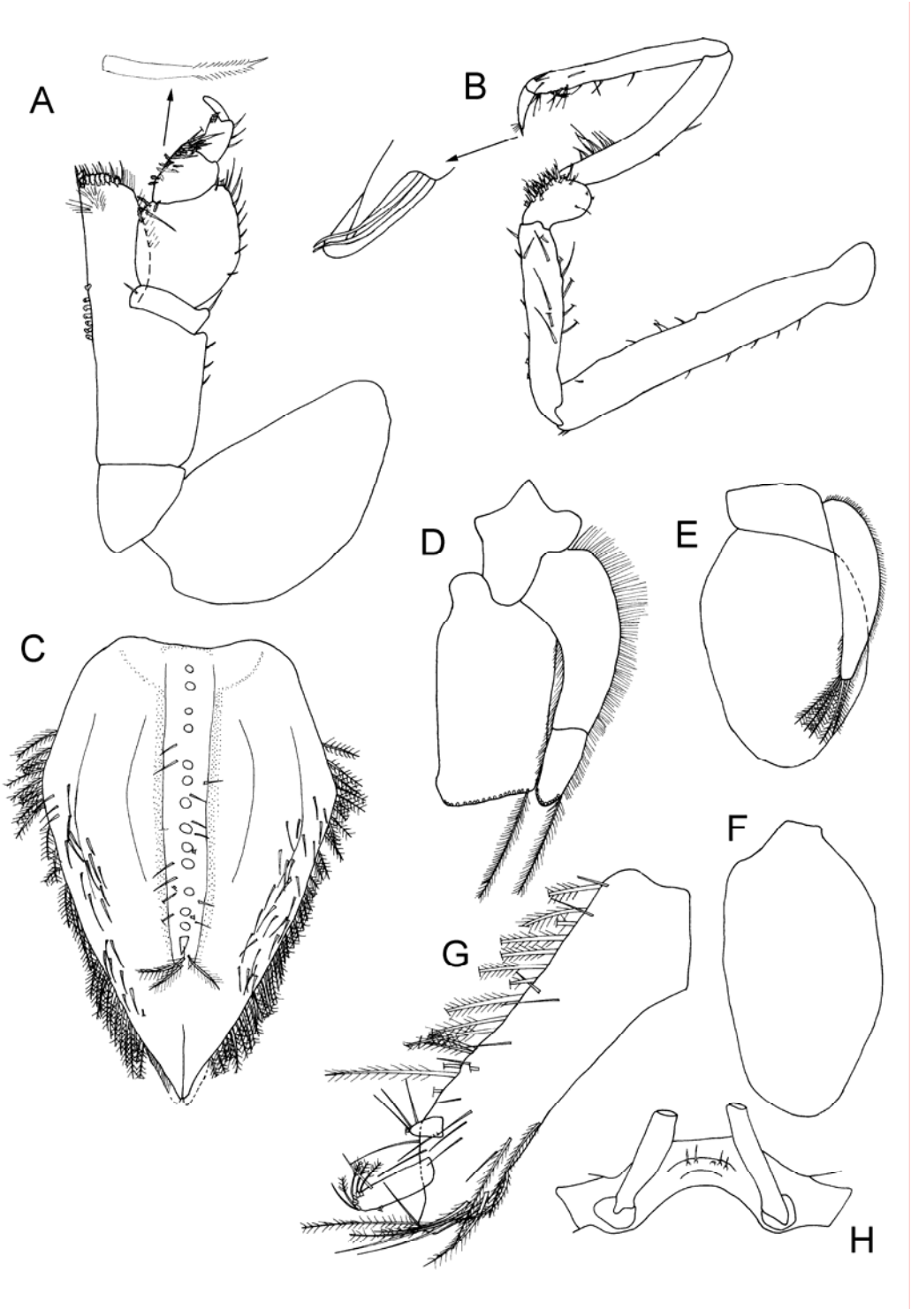
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Figure 4.60 *Notopais likros* n. sp. A, C, D, female holotype, 4.2 mm (AM PXXXX); B, female paratype, 3.8 mm (AM PXXXX); E, F, female paratype, 3.4 mm (AM P62634); G, male paratype, 2.0 mm (AM P62639). A, dorsal view; B, ventral view of pereonite 7 and pleon; C, lateral view; D, cephalon; E, left antenna 2; F, left antenna 1; G, left antenna 1. Scale bar = 1 mm, for dorsal and lateral views only.

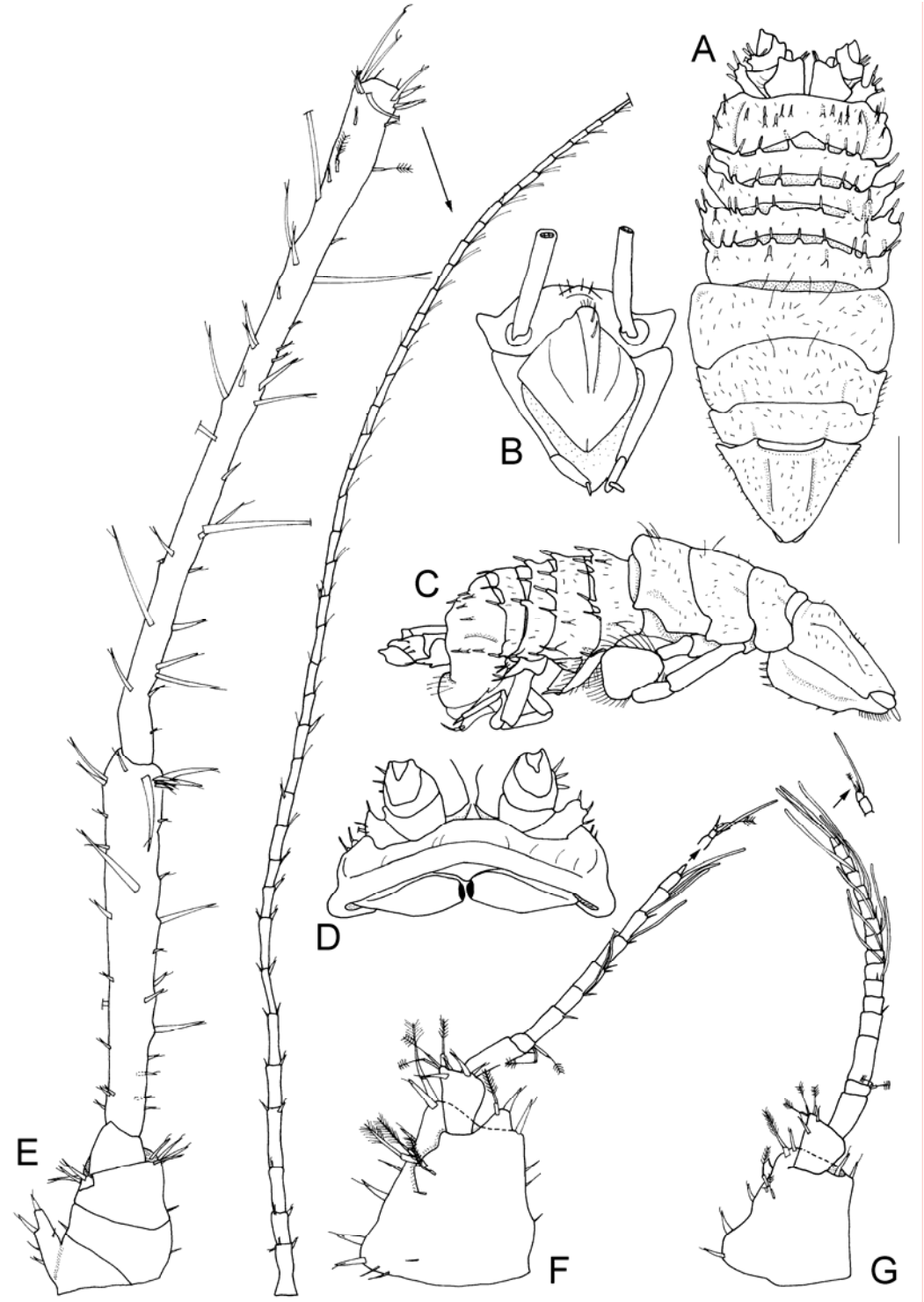
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Figure 4.61 *Notopais likros* n. sp. All figures from female paratype, 3.4 mm (AM P62634). A, left mandible; B, right mandible; C, left maxilliped; D, left maxilla 1; E, left maxilla 2.

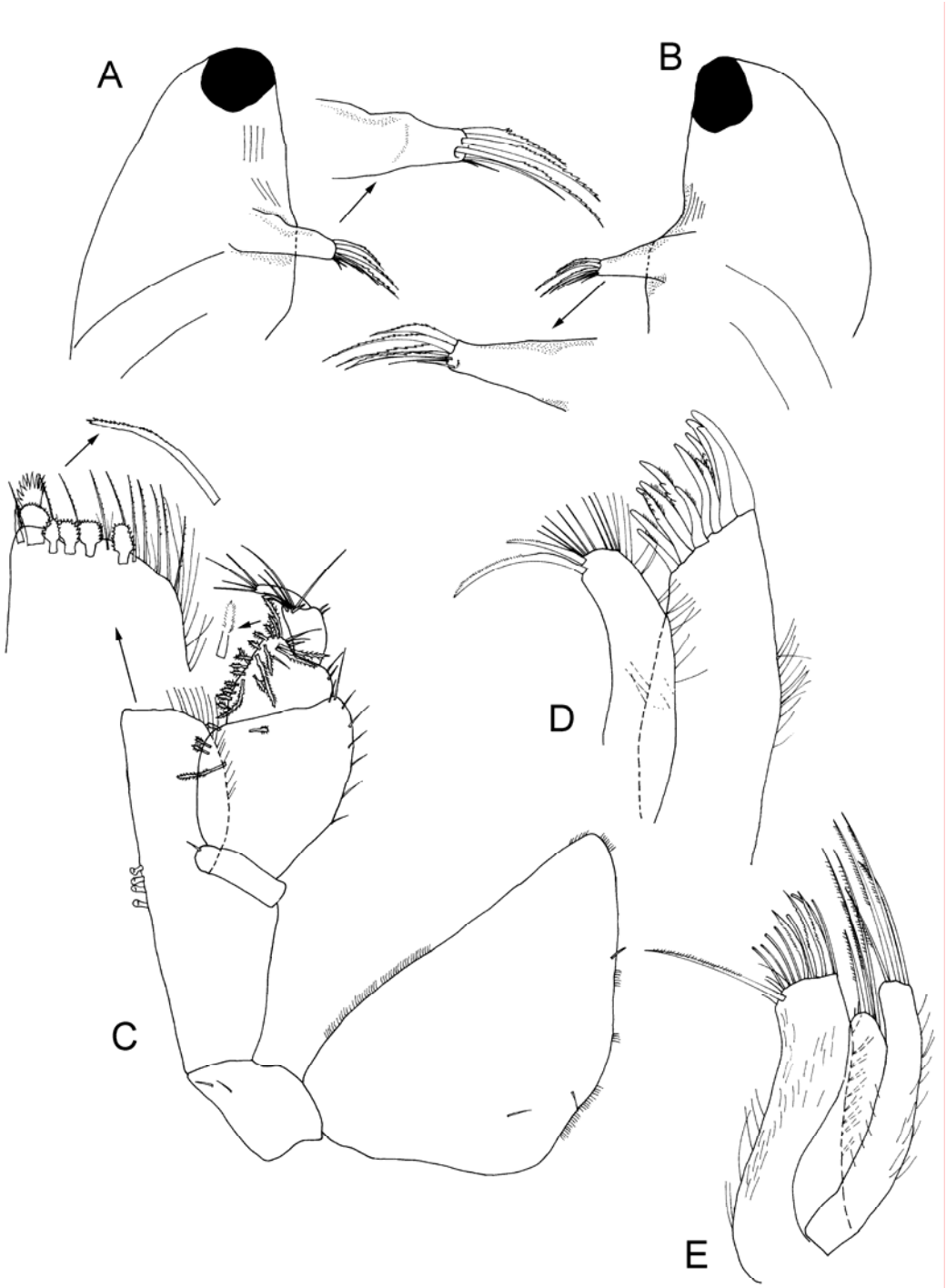
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Figure 4.62 *Notopais likros* n. sp. All figures from female paratype, 3.4 mm (AM P62634). A, right pereopod 2; B, left pereopod 5; C, left pereopod 6; D, left pereopod 1; E, right pereopod 7.

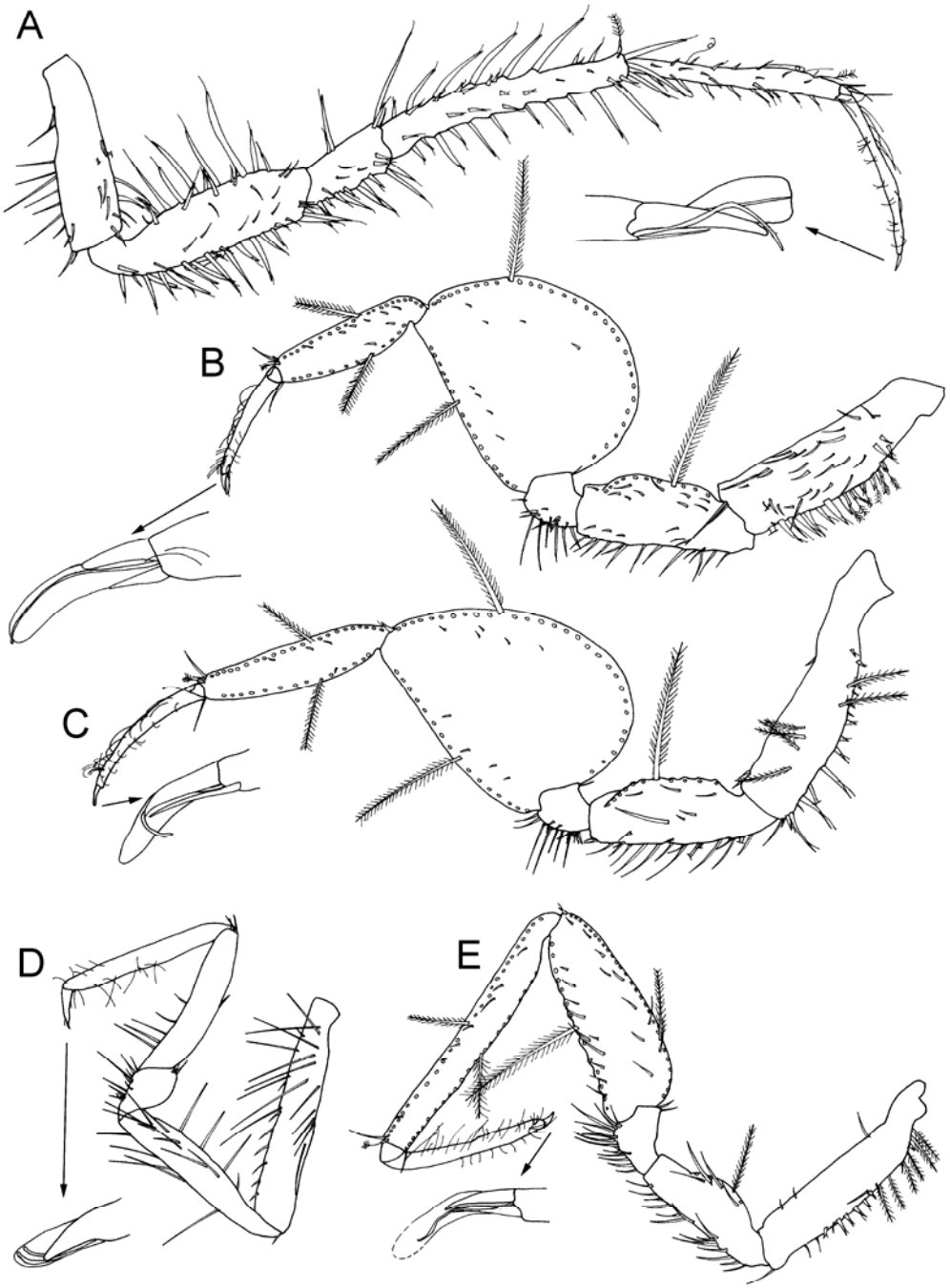
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Figure 4.63 *Notopais likros* n. sp. A, D–H, female paratype, 3.4 mm (AM P62634); B, C, male paratype, 2.0 mm (AM P62639). A, operculum; B, pleopod 1; C, right pleopod 2; D, left pleopod 3; E, left pleopod 4; F, left pleopod 5; G, left uropod; H, endopod and exopod of left uropod.

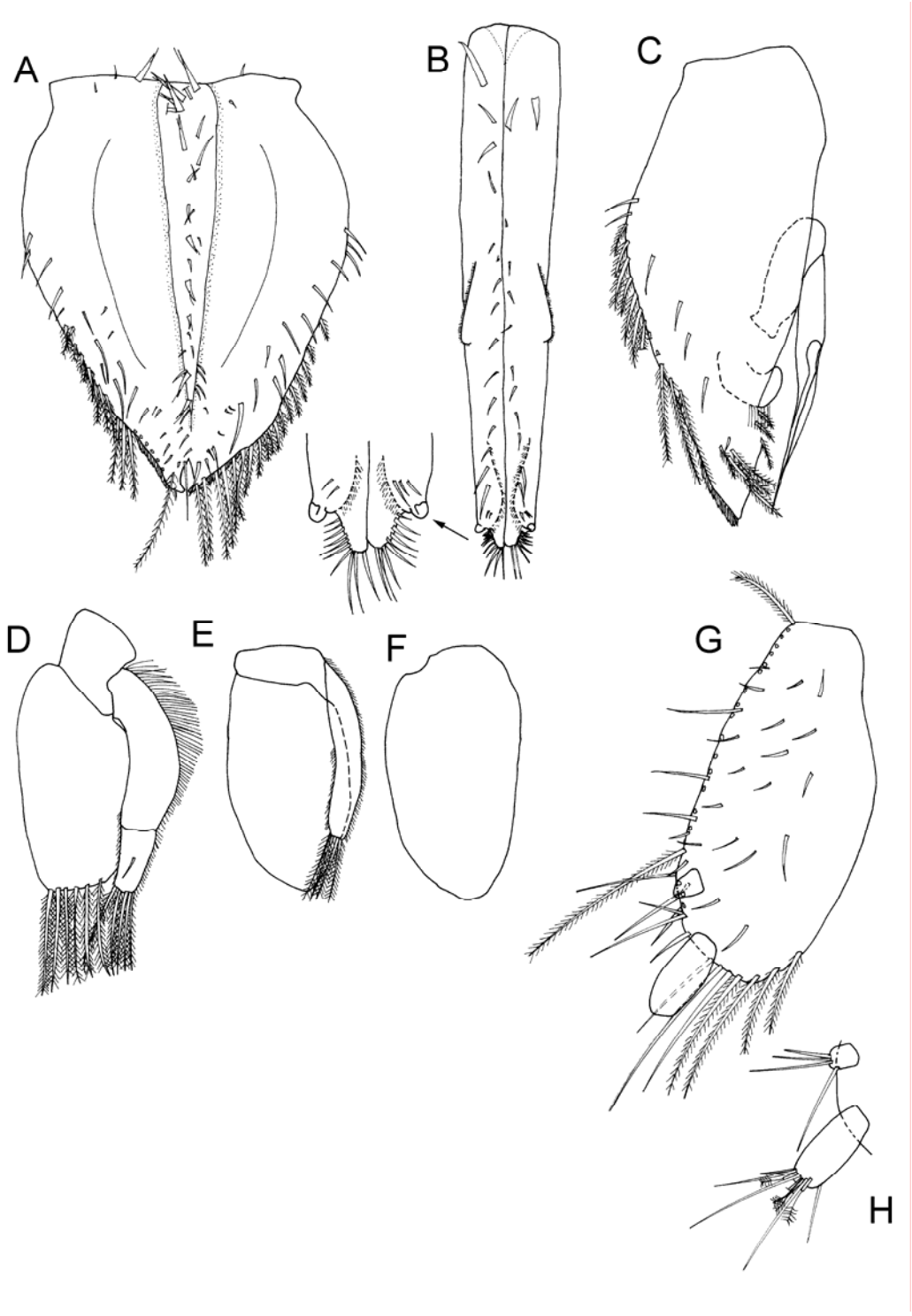
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Figure 4.64 *Notopais minya* Merrin, 2004b. A, B, female holotype, 5.0 mm (NMV J52877); C, E, female paratype, 4.0 mm (NMV J52876); D, male paratype, 4.0 mm (NMV J52876). A, dorsal view; B, lateral view; C, left antenna 1; D, right antenna 1; E, right antenna 2. Scale bar = 1 mm, for dorsal and lateral view only.

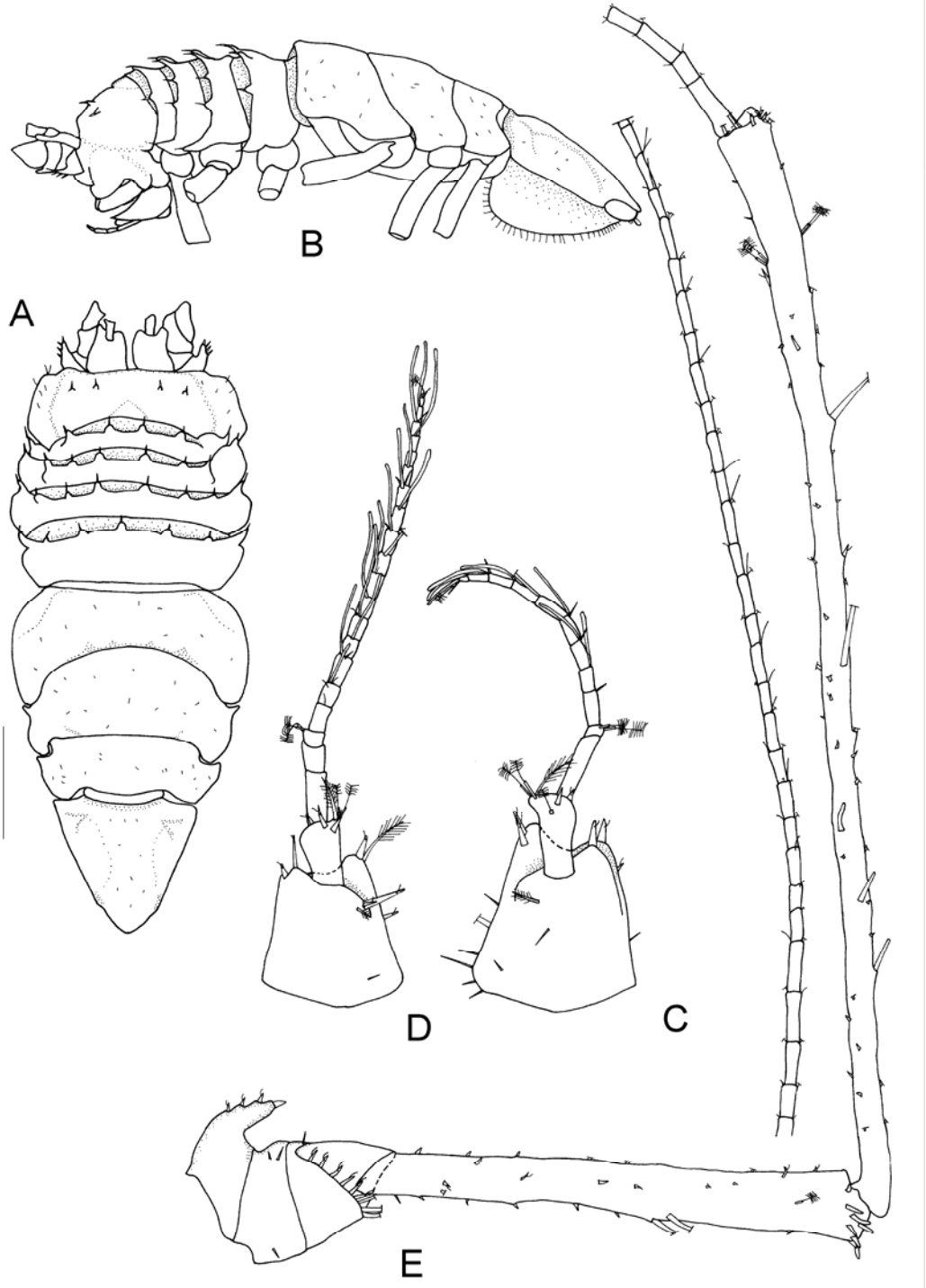
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Figure 4.65 *Notopais minya* Merrin, 2004b. All figures from female paratype, 4.0 mm (NMV J52876). A, left mandible; B, left mandibular molar (top) and right mandibular molar (bottom); C, right maxilla 1; D, left maxilla 2; E, left maxilliped; F, left pereopod 1; G, right pereopod 7.

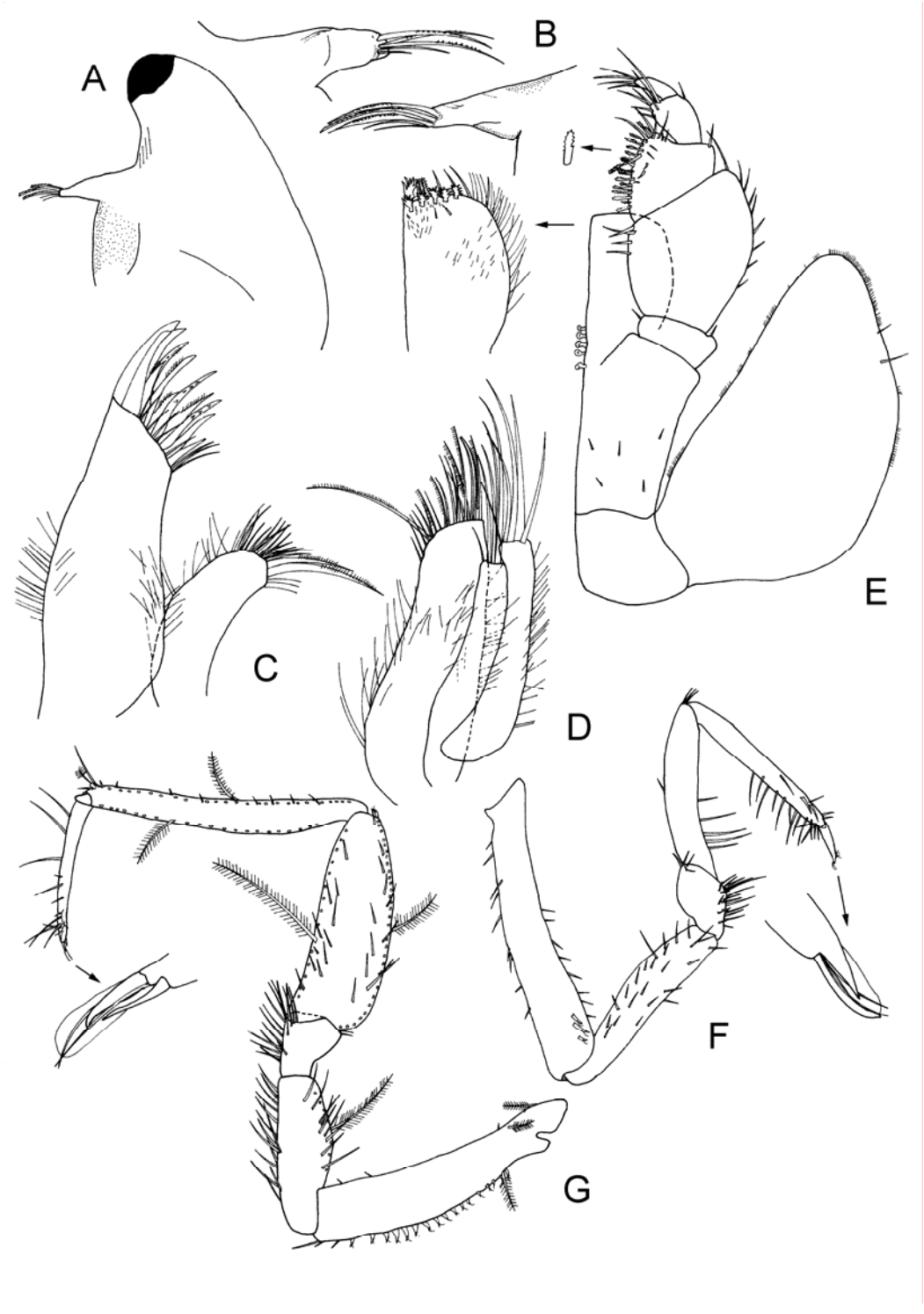
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Figure 4.66 *Notopais minya* Merrin, 2004b. A, B, D, E, female paratype, 4.0 mm (NMV J52876); C, female paratype, 4.5 mm (NMV J52876). A, left pereopod 5; B, right pereopod 6; C, operculum; D, left pleopod 3; E, left pleopod 4.

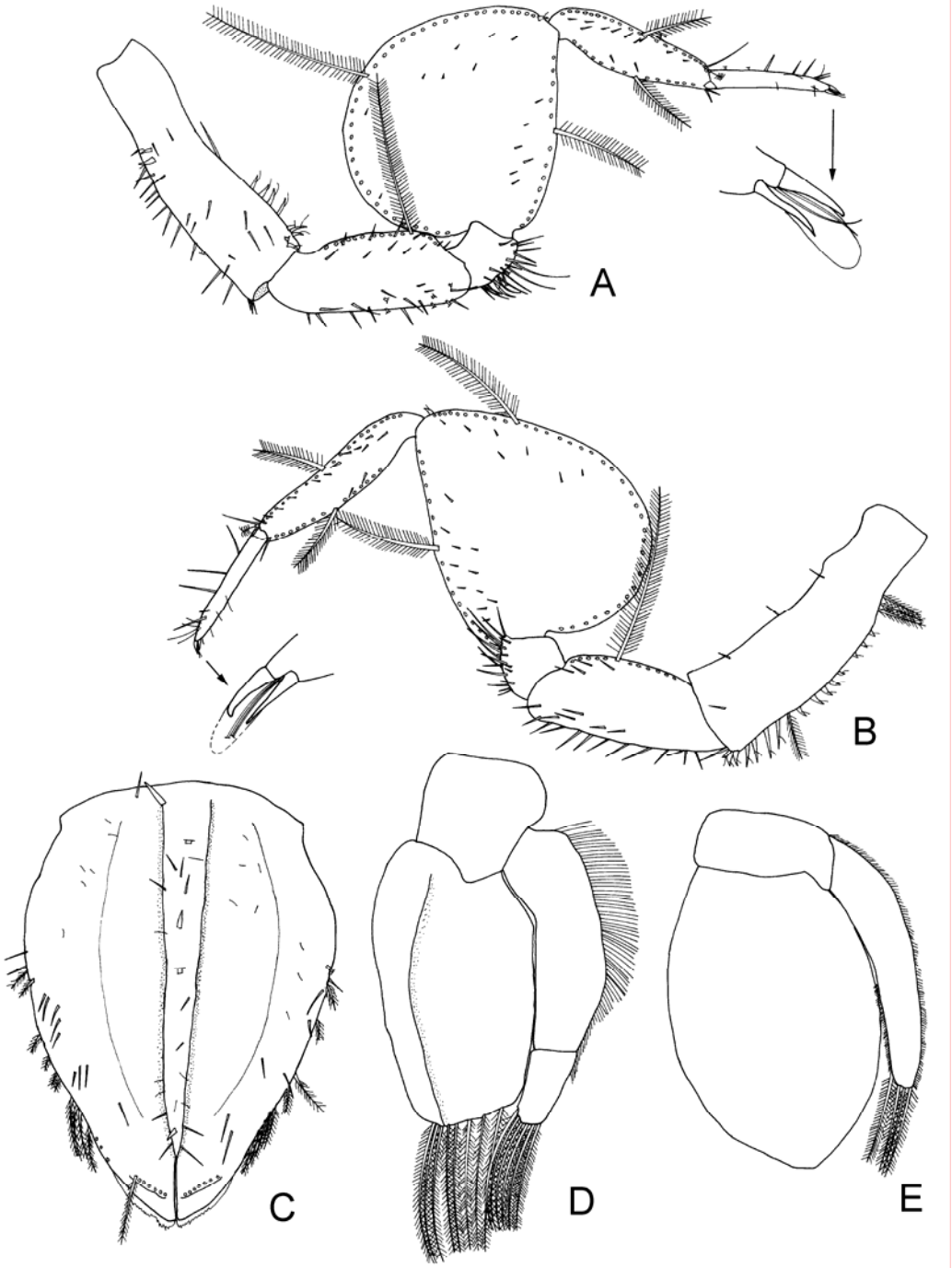
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Figure 4.67 *Notopais minya* Merrin, 2004b. A, D, E female paratype, 4.0 mm (NMV J52876); B, C, male paratype, 4.0 mm (NMV J52876). A, left pleopod 5; B, pleopod 1; C, left pleopod 2; D, left uropod; E, enlargement of distal part of left uropod.

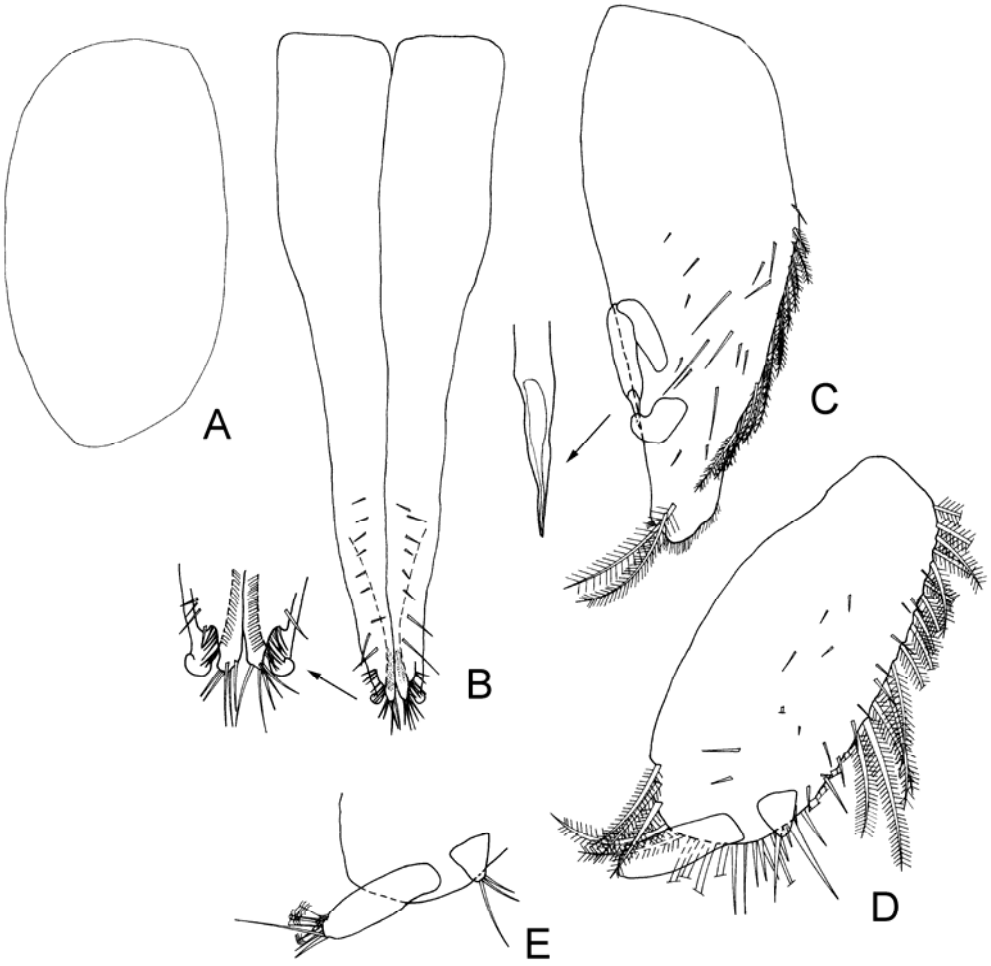
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Figure 4.68 *Notopais minya* Merrin, 2004b. A, D, male paratype, 2.0 mm (NMV J52876); B, C, males paratype, 3.5 mm (NIWA XXXX). A, antenna 2 articles 1–4; B, distally pappose setae on the maxilliped palp; C, unguis of pereopod 1; D, pereonite anterior marginal spine with remnants of the apical setae (affected by dehydration process).

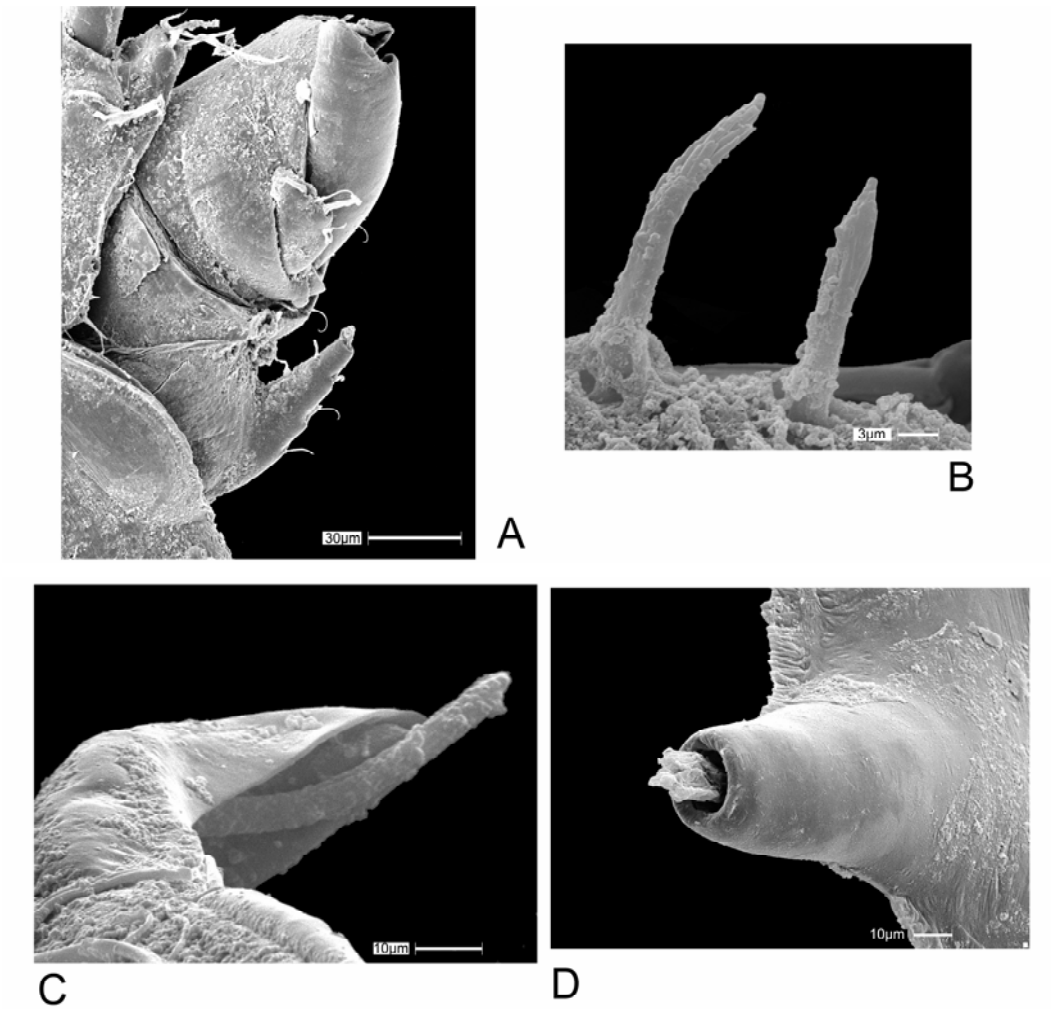
30µm
A
3µm
B
10µm
C
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Figure 4.69 *Notopais quadrispinosa* (Beddard, 1886). Female lectotype, 6.0 mm (BMNH 1889.4.27.73). A, dorsal view; B, lateral view; C, left antenna 1 and 2, dorsal view; D, left antenna 2, ventral view; E, right antenna 1 and 2; F, left pereopod 1; G, operculum. Scale bar = 1 mm, for dorsal and lateral views only.

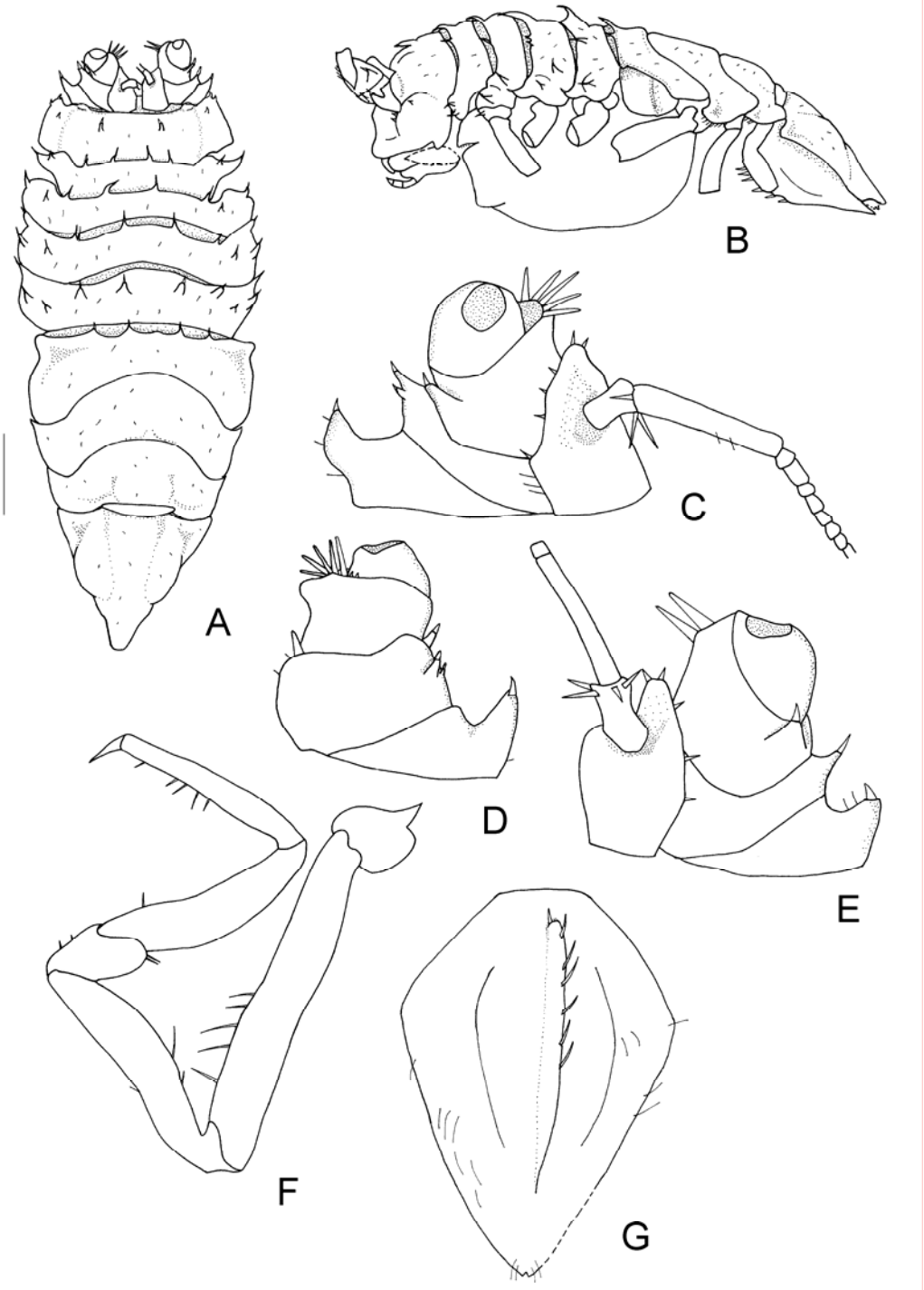
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Figure 4.70 *Notopais spicata* Hodgson, 1910. A, D–I, female holotype, 3 mm (BMNH 1910.3.18.150); B, C, Vanhöffen's specimen, male, 3 mm (ZMHB 17739). A, dorsal view; B, lateral view; C, dorsal view; D, left antenna 1; E, right antenna 2; F, right pereopod 1; G, left pereopod 7; H, operculum; I, operculum, lateral view. Scale bar = 1 mm, for Figure A only.

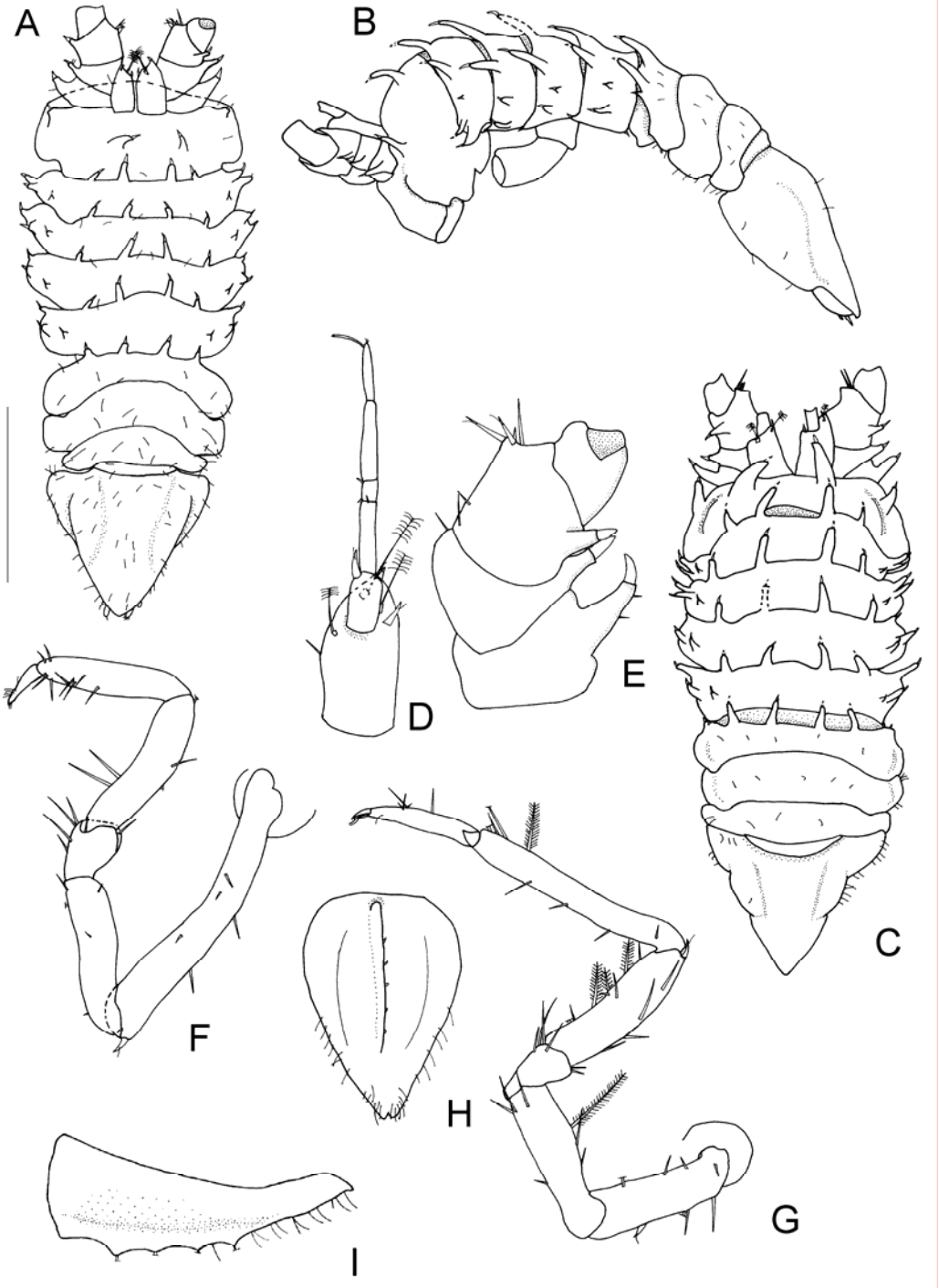
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Figure 4.71 *Notopais spicata* Hodgson, 1910. A, C–H, female, 5.5 mm (NIWA XXXX); B, female, 7.0 mm (NIWA XXXX). A, cephalon; B, ventral view of pereonite 7 and pleon; C, left antenna 1; D, left antenna 2; E, left mandible; F, right mandible; G, left maxilla 1; H, left maxilla 2.

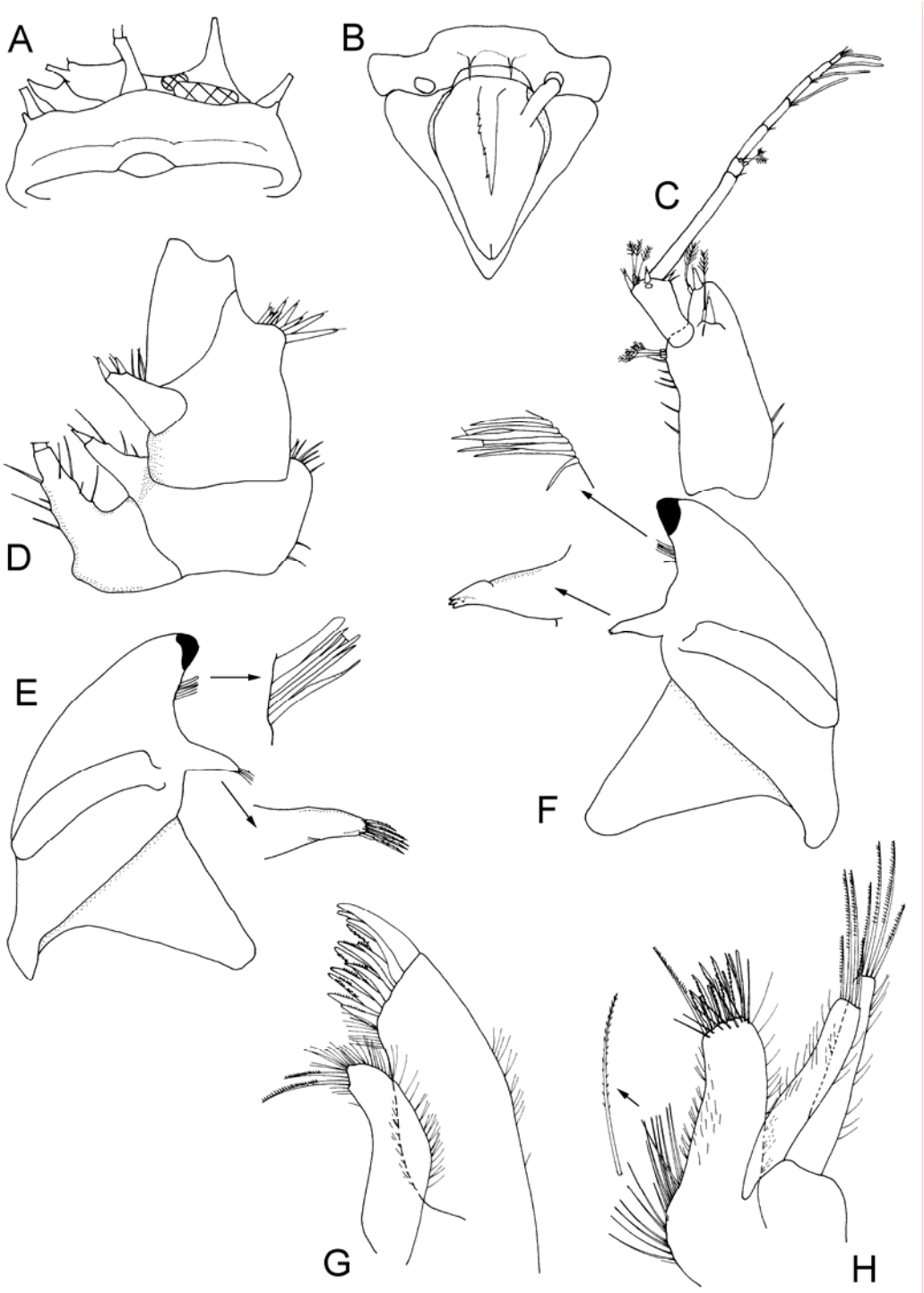
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Figure 4.72 *Notopais spicata* Hodgson, 1910. All figures from female, 5.5 mm (NIWA XXXX); A, left maxilliped; B, distal part of left maxilliped endite; C, right pereopod 1; D, right pereopod 5; E, left pereopod 6.

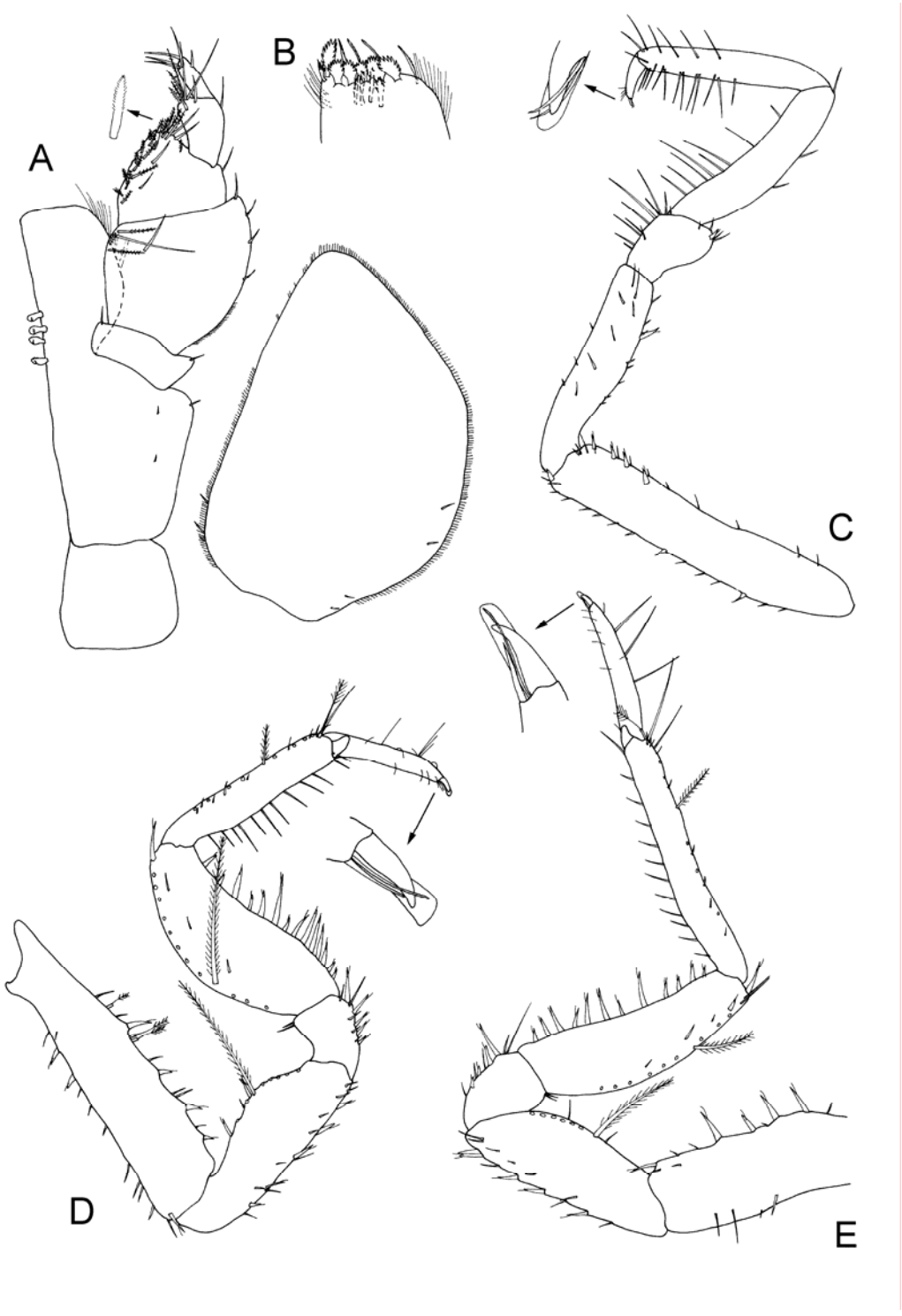
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Figure 4.73 *Notopais spicata* Hodgson, 1910. All figures from female, 5.5 mm (NIWA XXXX); A, operculum; B, left pleopod 3; C, left uropod; D, endopod and exopod of left uropod; E, right pleopod 4; F, right pleopod 5.

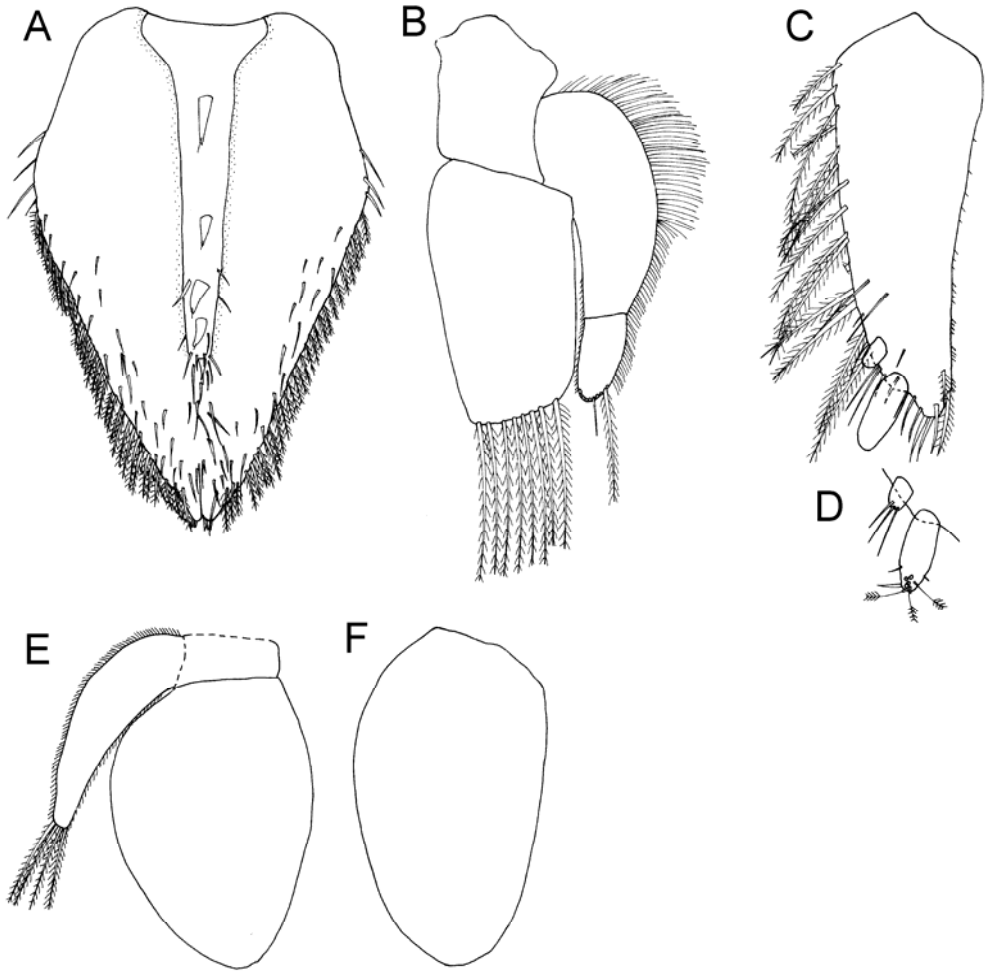
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Figure 4.74 *Notopais spinosa* (Hodgson, 1902). A, B, female syntype, 11.0 mm (BMNH 1901.12.13.7); C–I, female, 10.0 mm (NIWA XXXX). A, lateral view; B, dorsal view, C, left antenna 2; D, left antenna 1; E, cephalon; F, right mandible; G, right mandibular molar; H, left mandible; I, left mandibular molar. Scale bar = 1 mm, for dorsal and lateral views only.

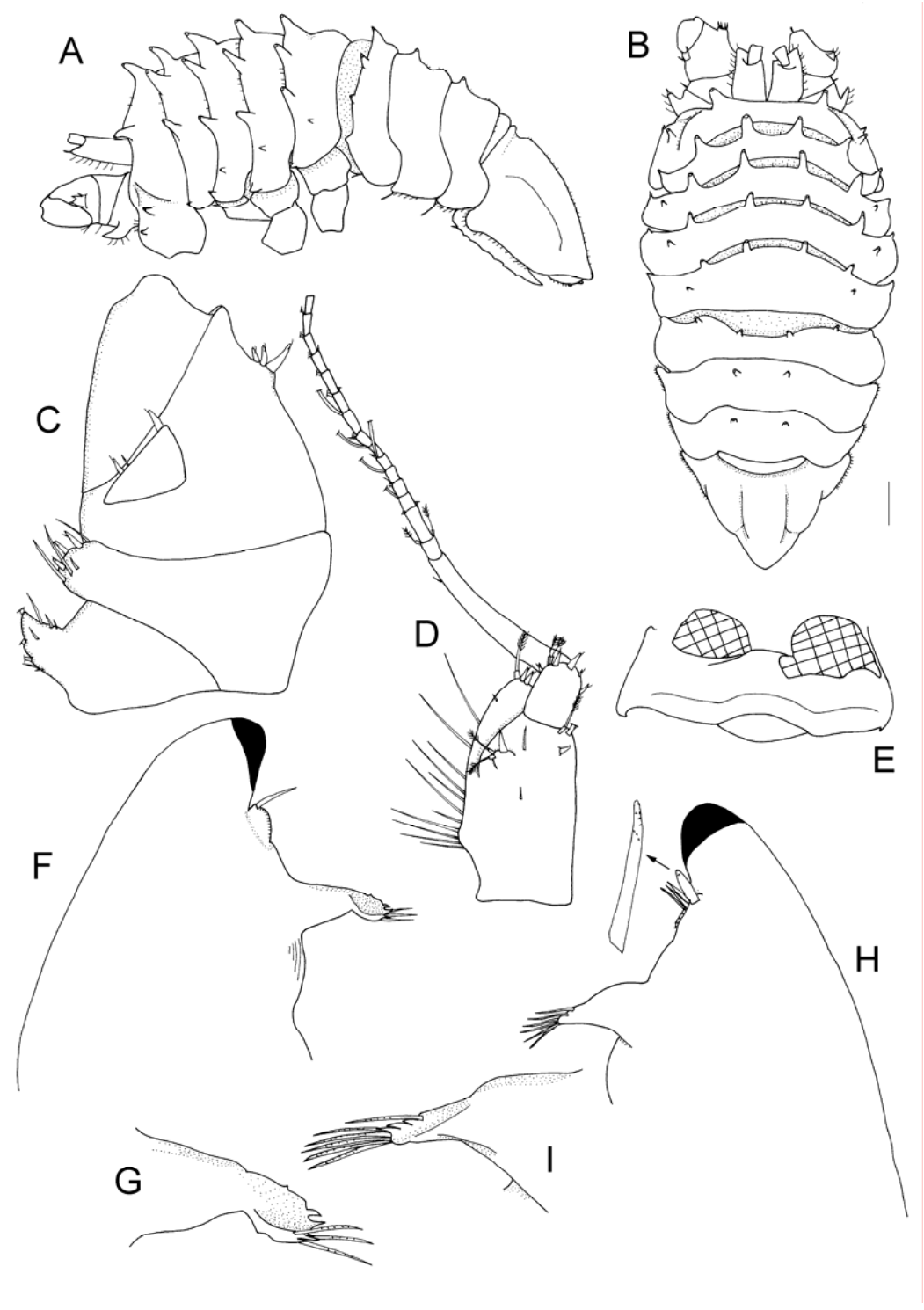
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Figure 4.75 *Notopais spinosa* (Hodgson, 1902). All figures from female, 10.0 mm (NIWA XXXX). A, left maxilla 1; B, left maxilla 2; C, left pereopod 2; D, left maxilliped palp; E, right maxilliped.

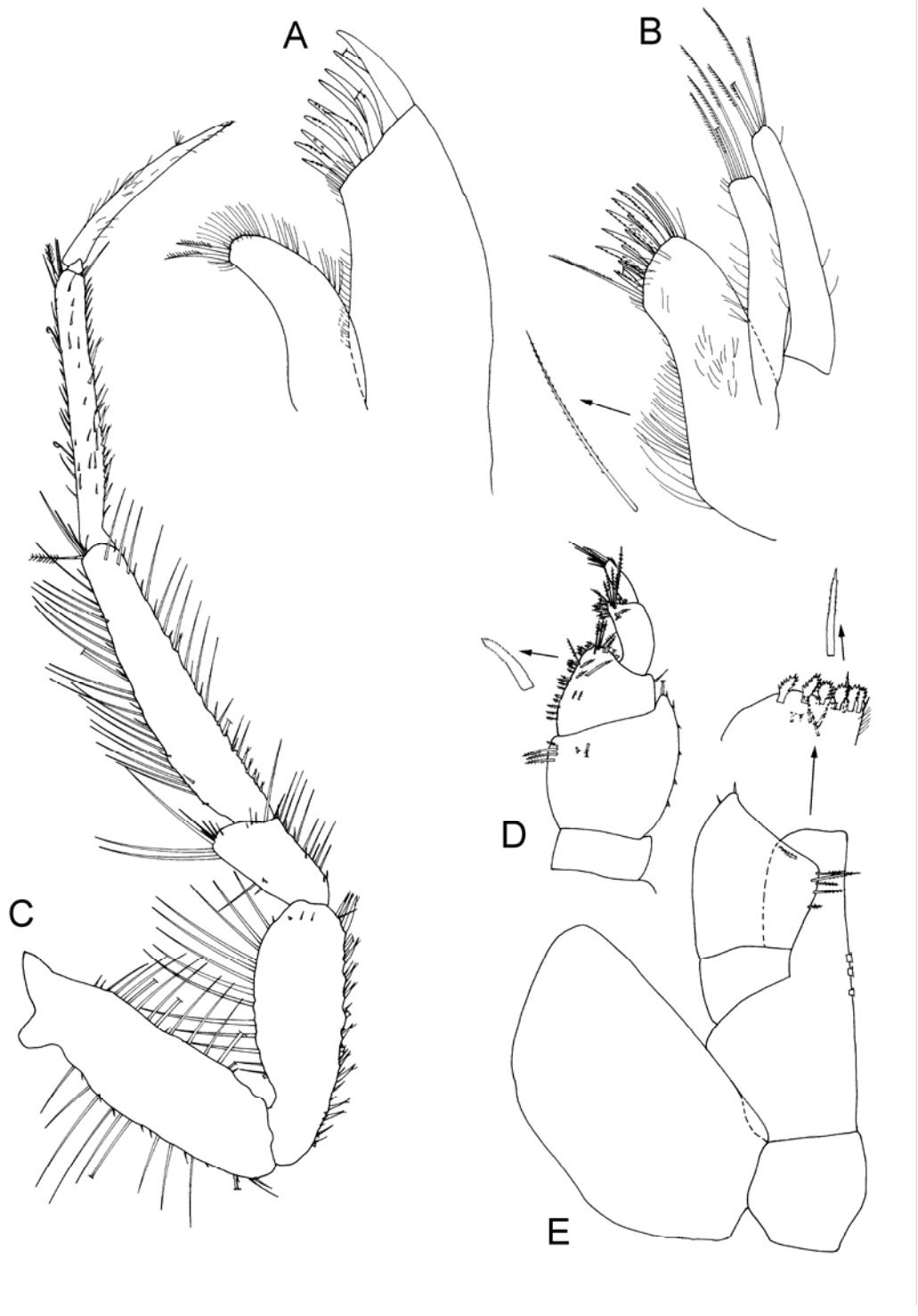
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Figure 4.76 *Notopais spinosa* (Hodgson, 1902). All figures from female, 10.0 mm (NIWA XXXX). A, left pereopod 1; B, left pereopod 5; C, left pereopod 6; D, left pereopod 7.

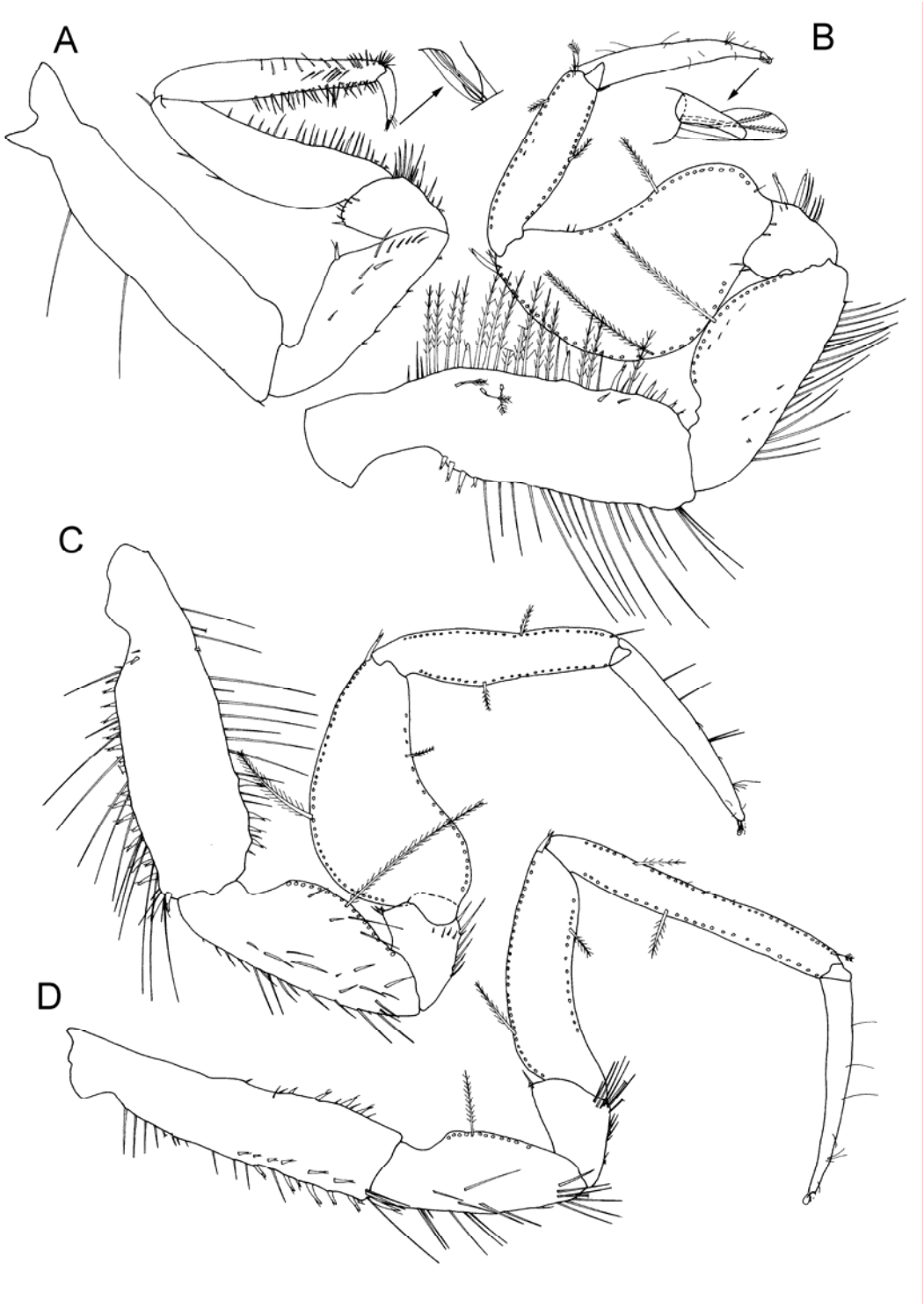
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Figure 4.77 *Notopais spinosa* (Hodgson, 1902). All figures from female, 10.0 mm (NIWA XXXX). A, operculum; B, left pleopod 3; C, left pleopod 4; D, lateral view of pereonite 7 and pleon; E, ventral view of pereonite 7 and pleon; F, left pleopod 5; G, right uropod; H, endopod and exopod of right uropod.

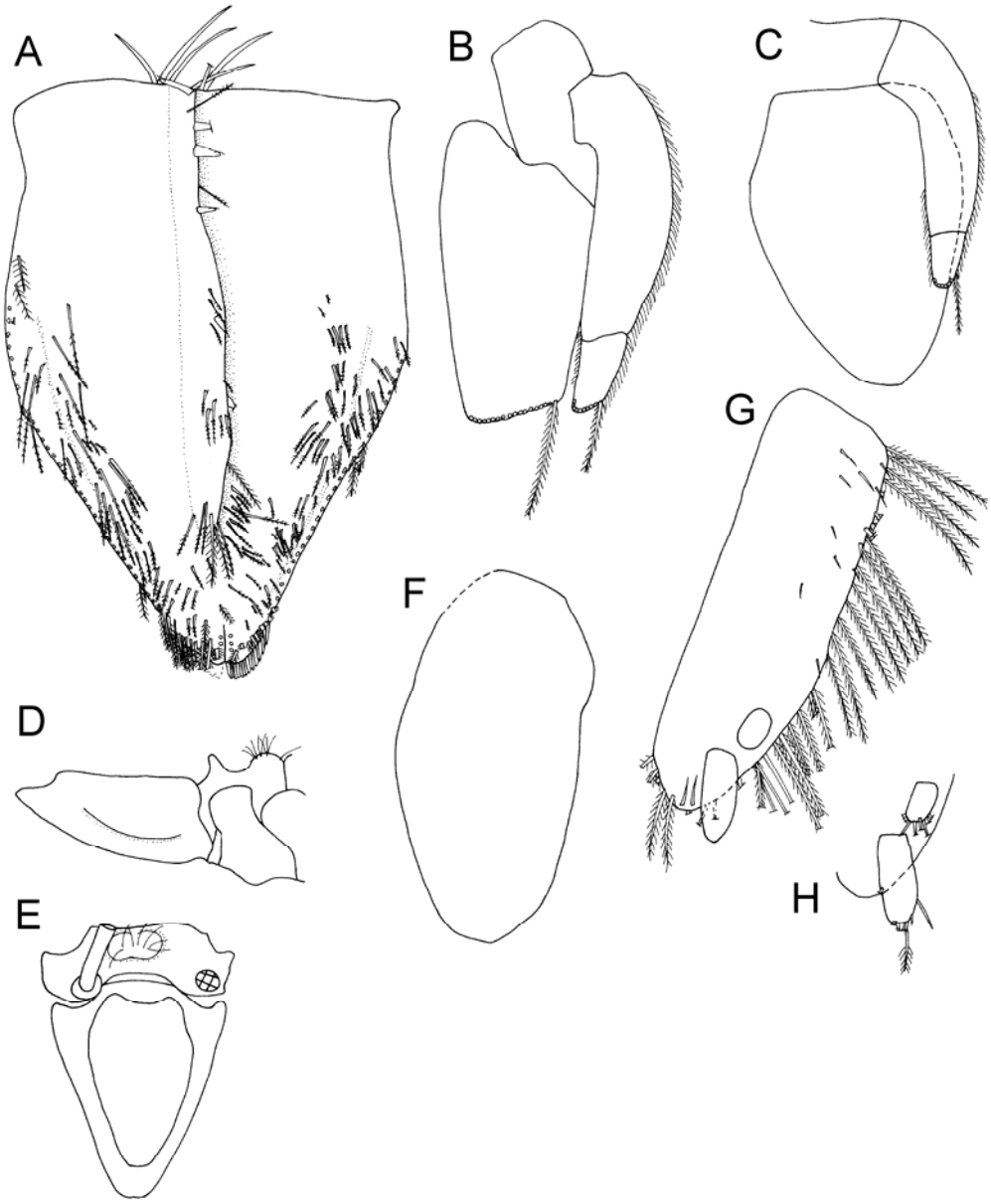
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Figure 4.78 *Notopais zealandica* Merrin, 2004b. A, B female holotype, 4.5 mm (NIWA 3303); C–H, female paratype, 4.5 mm (NIWA 3304). A, dorsal view; B, lateral view; C, left antenna 1; D, right antenna 2; E, right mandible; F, right mandibular molar (top) and left mandibular molar (bottom); G, right maxilliped; H, right maxilliped palp. Scale bar = 1 mm, for dorsal and lateral views only.

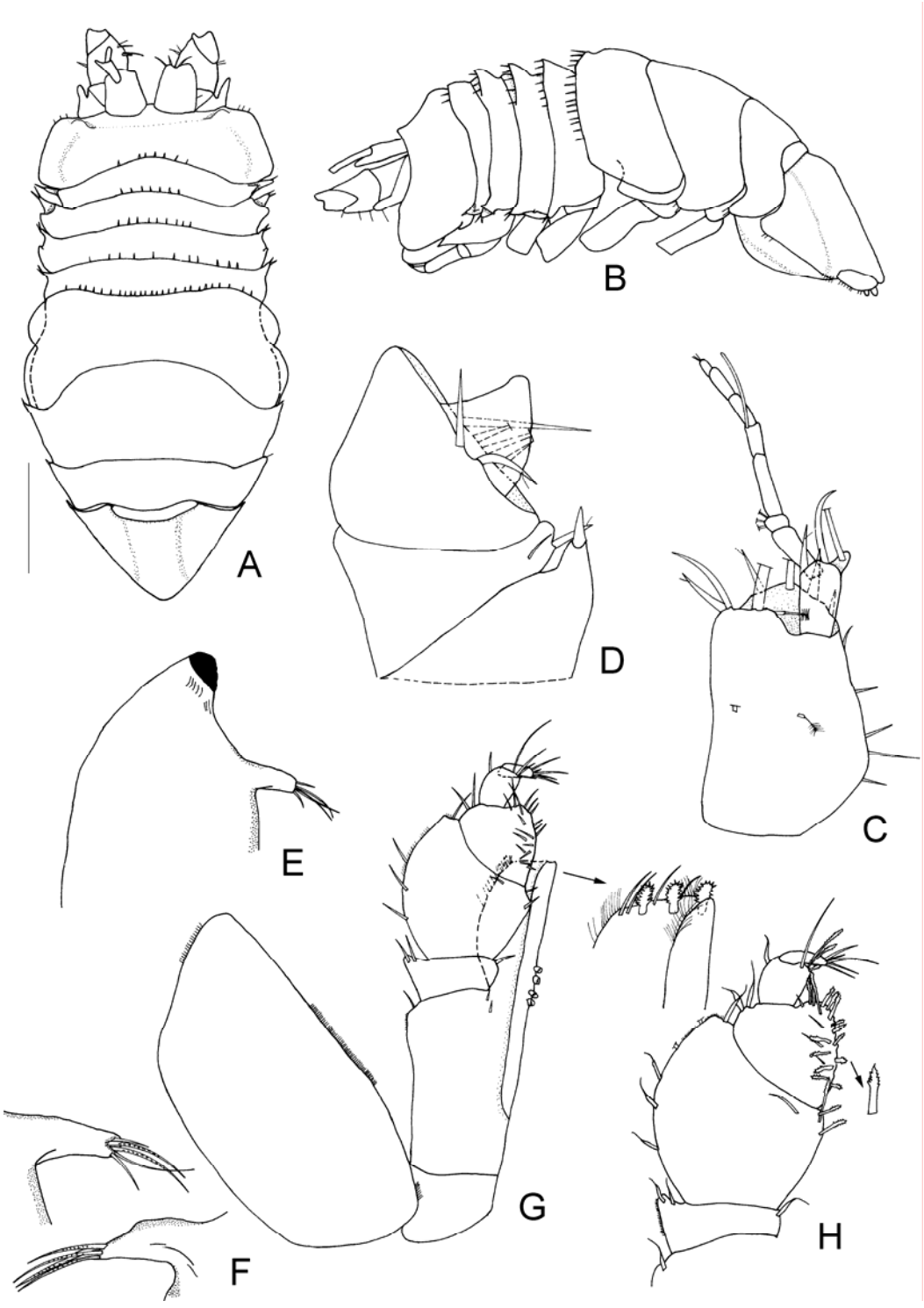
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Figure 4.79 *Notopais zealandica* Merrin, 2004b. A, B female paratype, 4.5 mm (NIWA 3304); C–E female holotype, 4.5 mm (NIWA 3303). A, right maxilla 1; B, right maxilla 2; C, right pereopod 1; D, left pereopod 5; E, left pereopod 6.

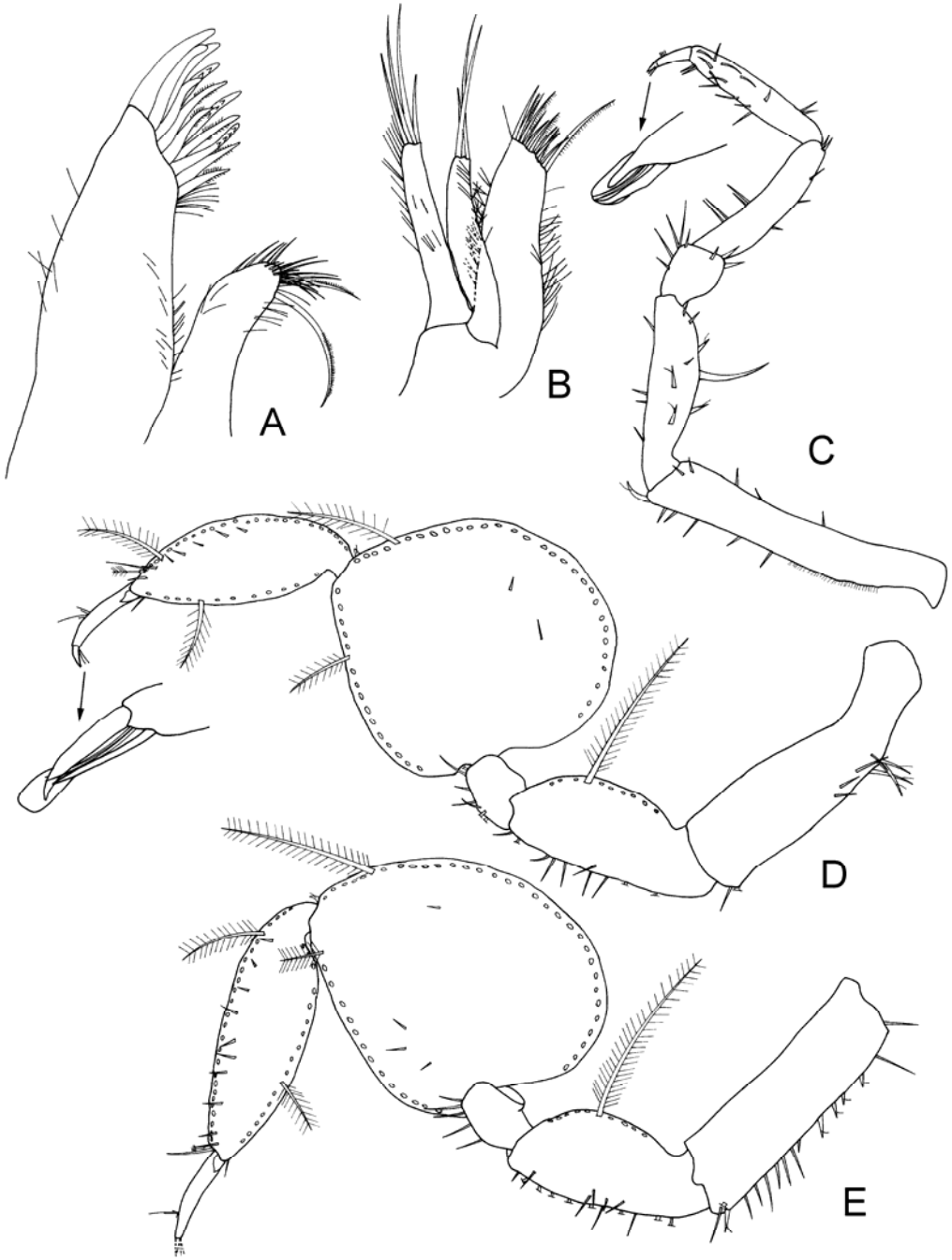
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Figure 4.80 *Notopais zealandica* Merrin, 2004b. A, female paratype, 3.5 mm (NIWA 3304); B–E, female paratype, 4.5 mm (NIWA 3304). A, operculum; B, left pleopod 3; C, left pleopod 4, D, left pleopod 5; E, left uropod.

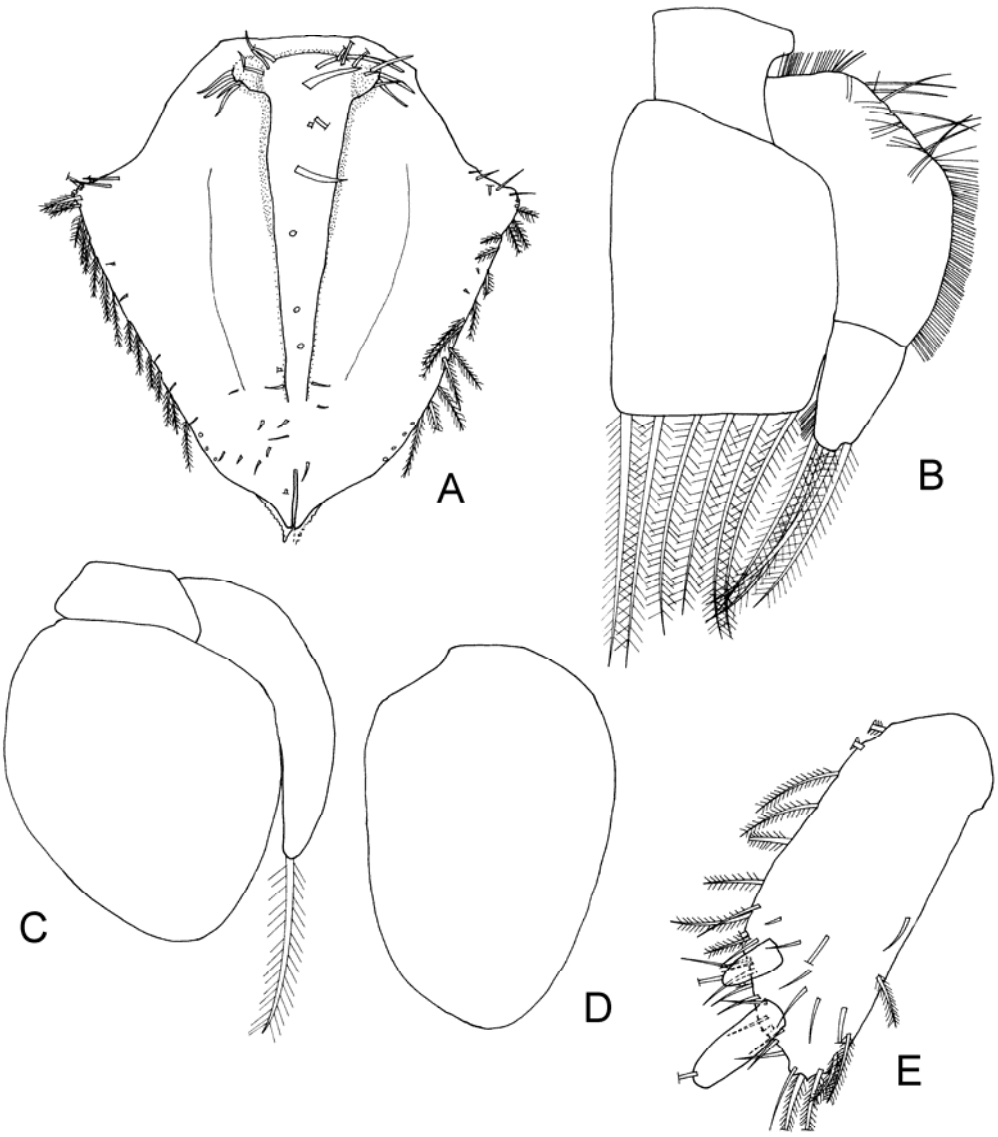
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Figure 4.81 *Nyctobadistes hamatus* n. sp. A–F, male holotype, 3.2 mm (NIWA XXXX); G, I–K, female paratype, 5.0 mm (NIWA XXXX); H, male paratype, 3.0 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, dorsal view of cephalon; E, lateral view of pereonites 6, 7 and pleon; F, ventral view of pereonites 6 and 7; G, left antenna 1; H, right antenna 1; I, left antenna 2; J, right pereopod 1; K, unguis of right pereopod 1. Scale bar = 1 mm, for dorsal and lateral views only.

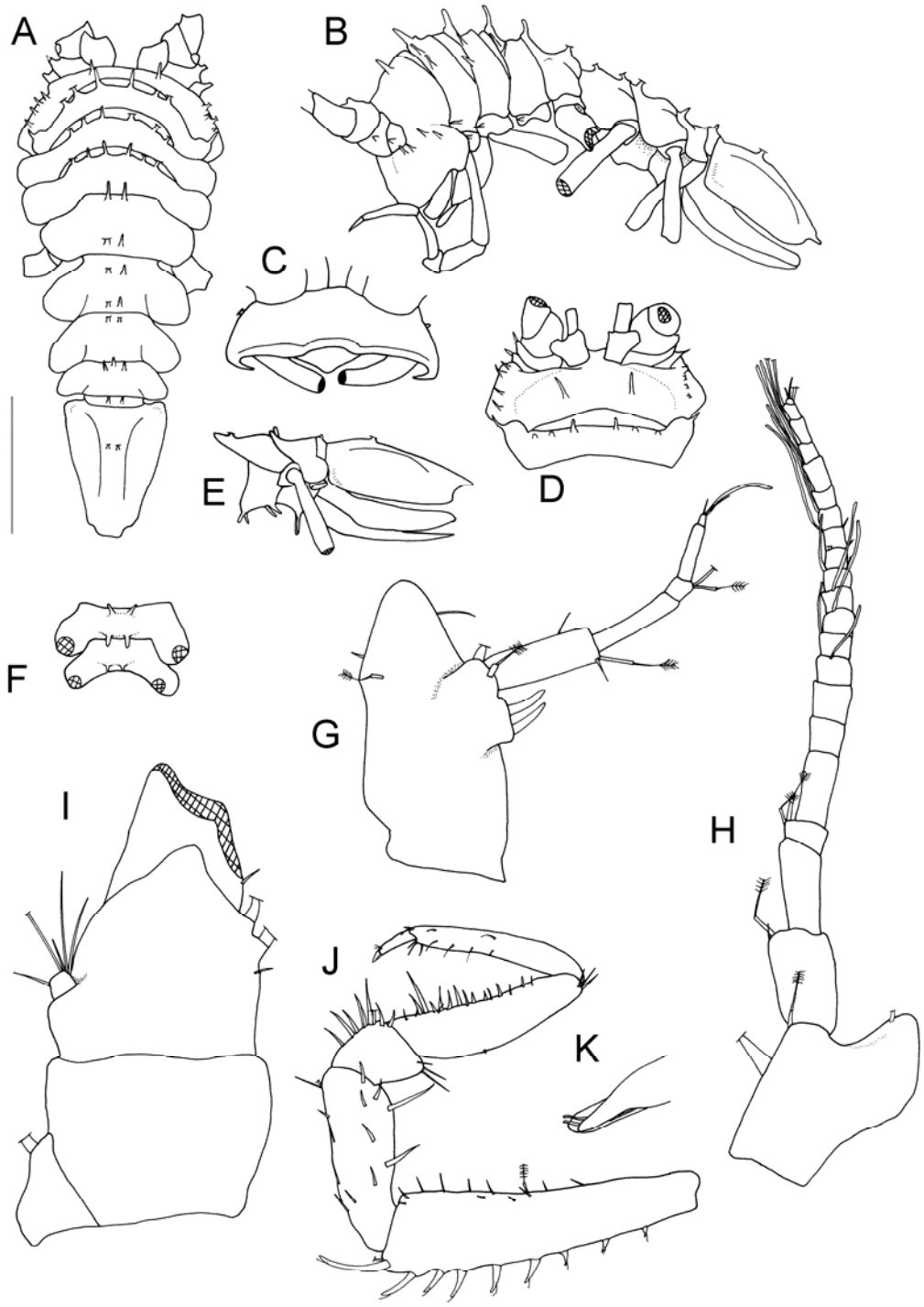
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Figure 4.82 *Nyctobadistes hamatus* n. sp. A–F, female paratype, 5.0 mm (NIWA XXXX); G, male holotype, 3.2 mm (NIWA XXXX). A, left mandible; B, right mandible; C, right maxilla 1; D, left maxilla 2; E, left maxilliped; F, left maxilliped palp articles 4 and 5; G, right pereopod 6.

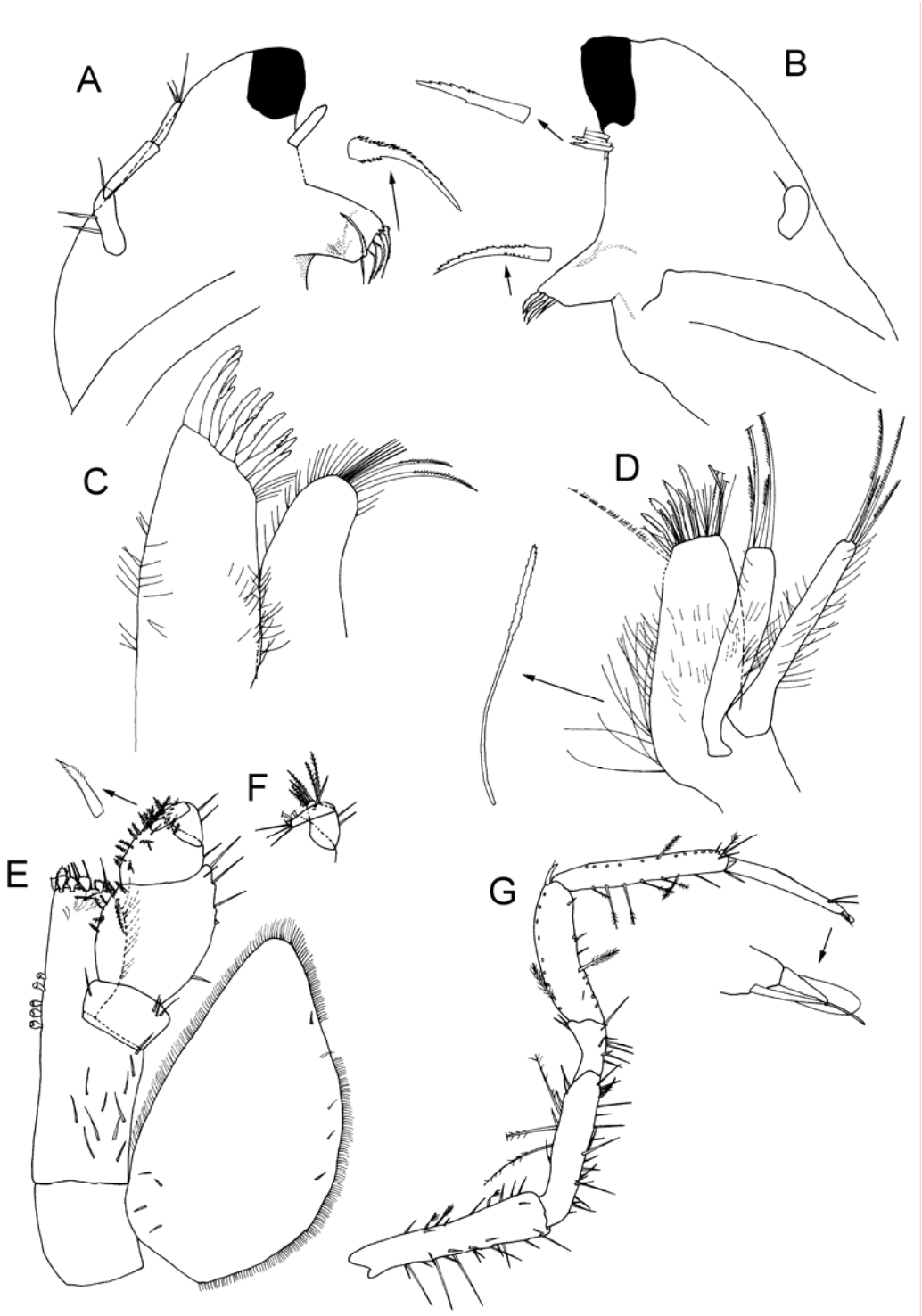
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Figure 4.83 *Nyctobadistes hamatus* n. sp. A, male holotype, 3.2 mm (NIWA XXXX); B, F–H, female paratype, 5.0 mm (NIWA XXXX); C–E, male paratype, 3.0 mm (NIWA XXXX). A, left pereopod 7; B, operculum; C, pleopod 1; D, distal end of pleopod 1; E, left pleopod 2; F, left pleopod 3; G, left pleopod 4; H, left pleopod 5.

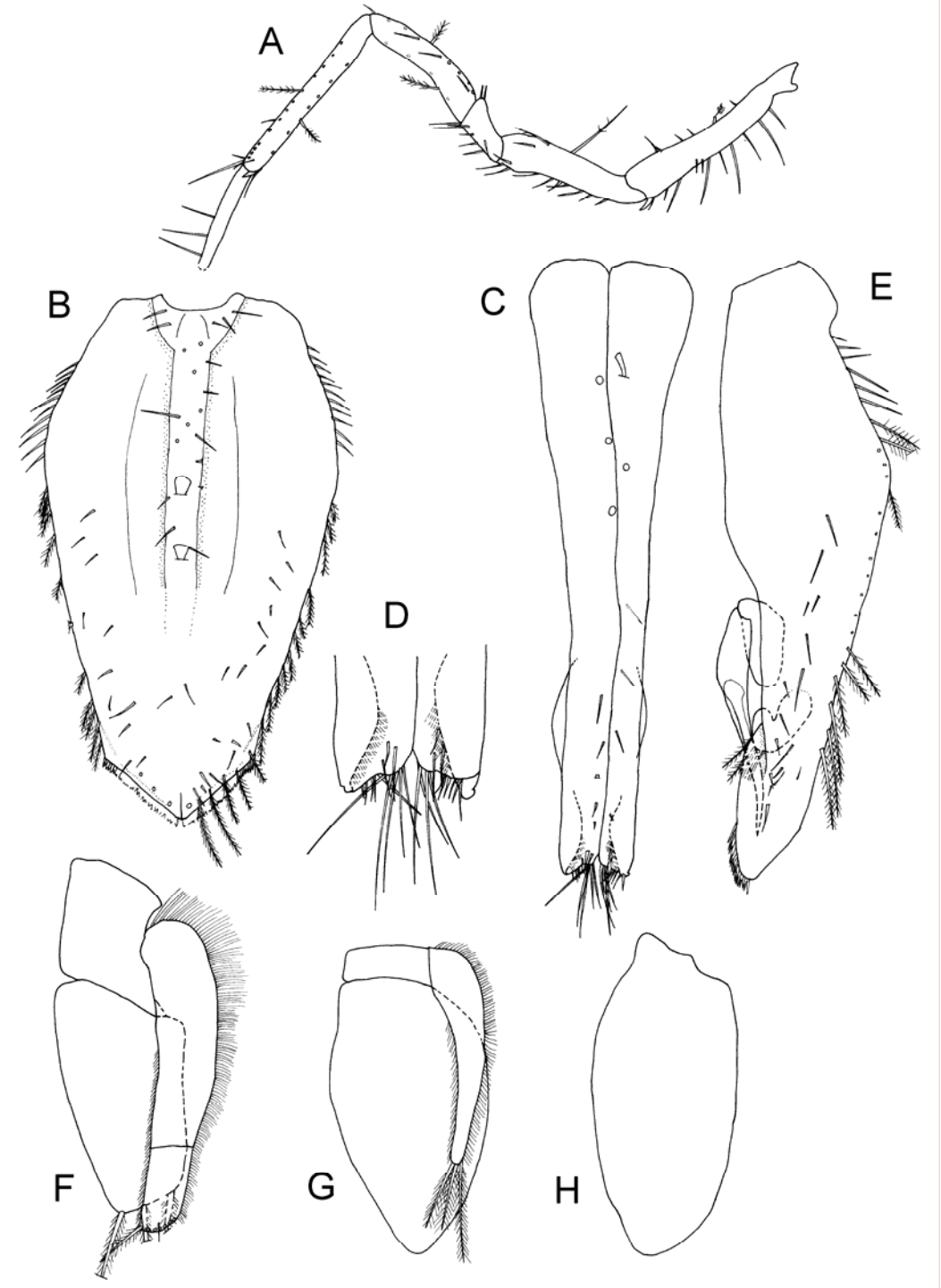
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Figure 4.84 *Pseudarachna nohinohi* n. sp. A–C, female holotype, 1.7 mm (NIWA XXXX); D, E, female paratype, 2.0 mm (NIWA XXXX); F–H, female paratype, 1.7 mm (NIWA XXXX). A, dorsal view; B, lateral view; C, cephalon; D, right antenna 1; E, right antenna 2; F, right mandible; G; left mandible; H, left uropod. Scale bar = 1 mm, for dorsal and lateral views only.

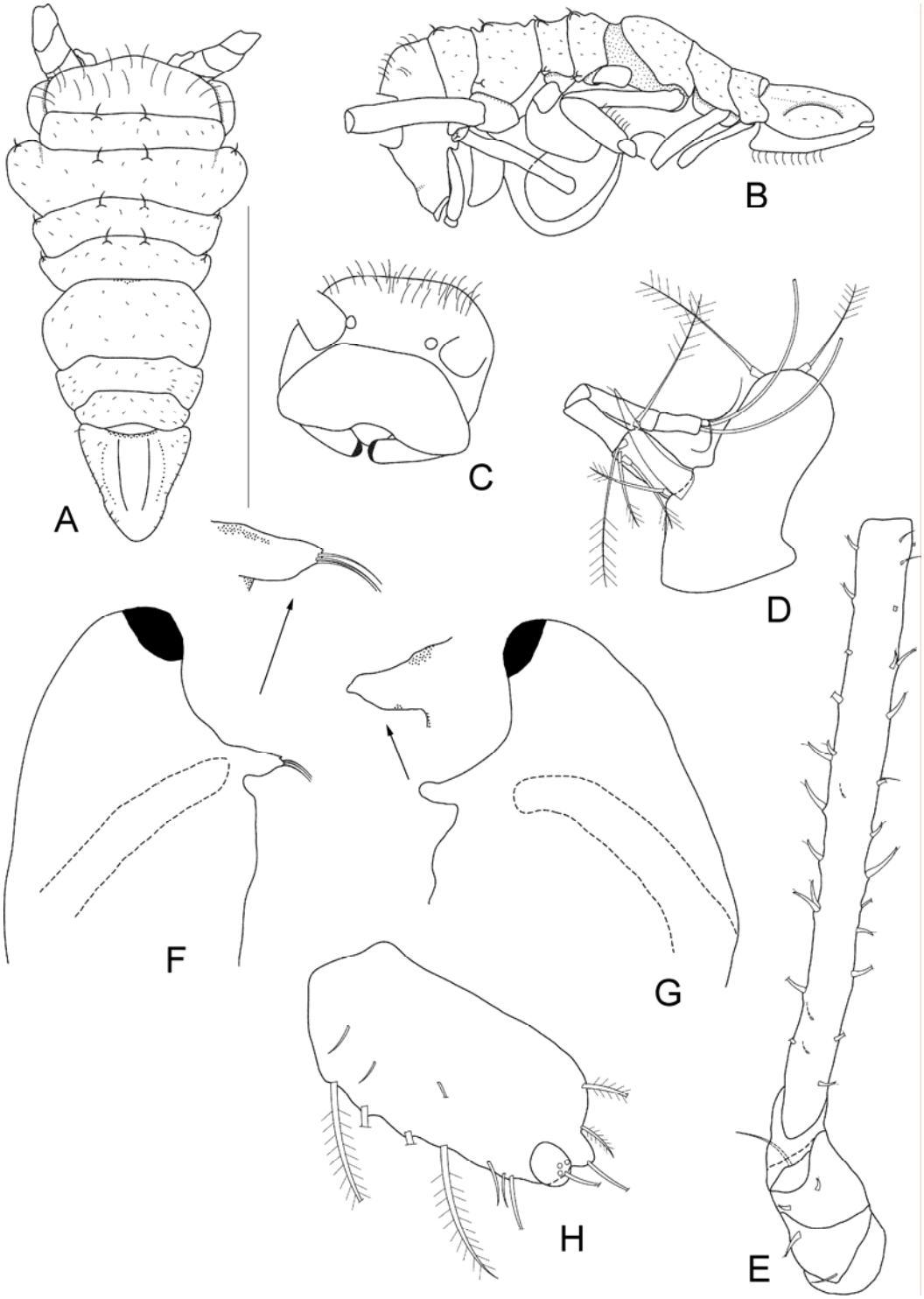
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Figure 4.85 *Pseudarachna nohinohi* n. sp. A–D, F, female paratype, 2.0 mm (NIWA XXXX); E, G, female paratype 1.7 mm (NIWA XXXX). A, right maxilliped; B, left maxilliped palp, articles 4 and 5; C, right maxilla 1; D, right maxilla 2; E, left pereopod 1; F, left pereopod 2; G, left pereopod 7.

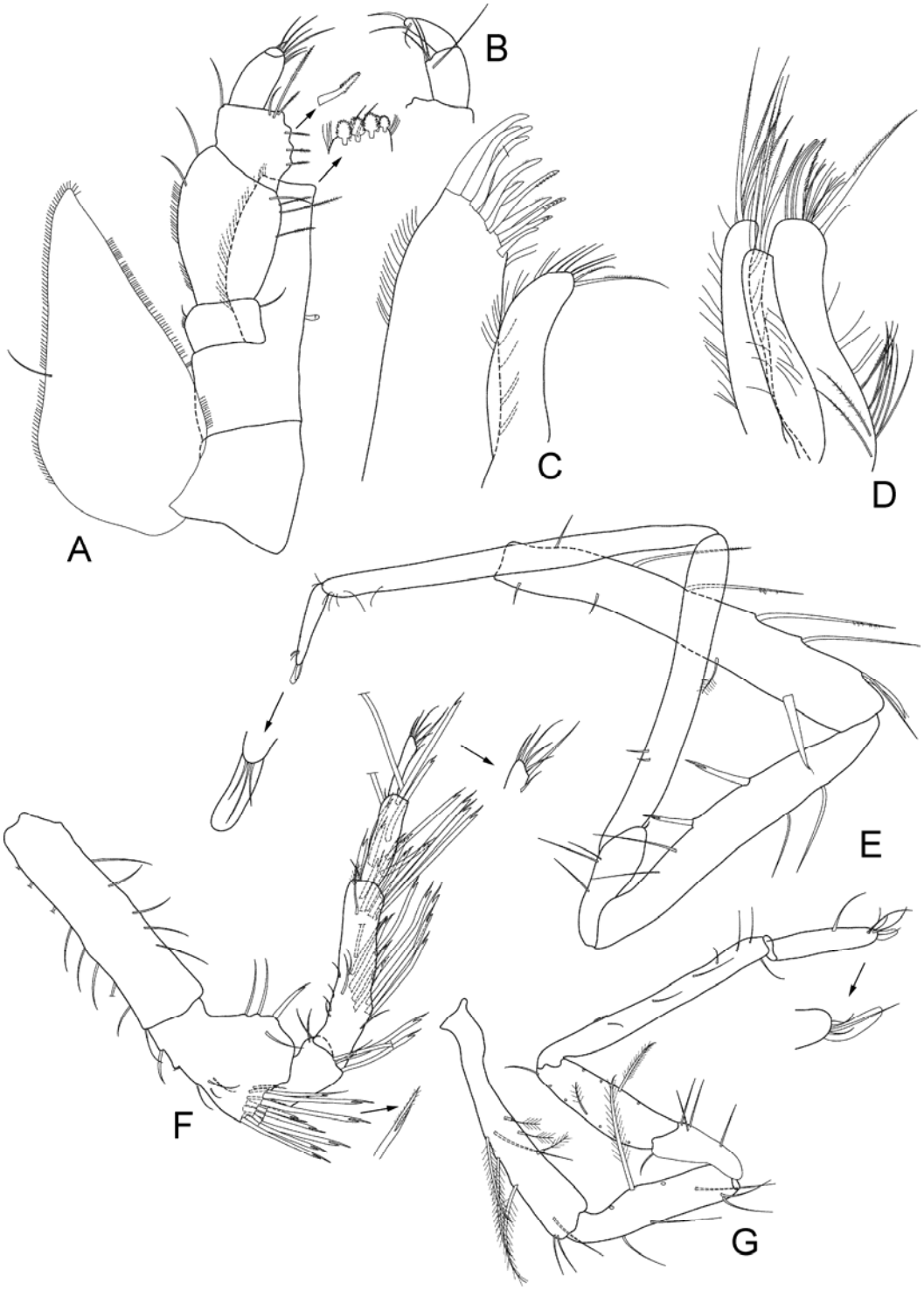
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Figure 4.86 *Pseudarachna nohinohi* n. sp. A, female paratype, 2.0 mm (NIWA XXXX); B, female paratype, 1.7 mm (NIWA XXXX); C–F, female paratype, 2.0 mm (NIWA XXXX). A, right pereopod 5; B, left pereopod 6; C, operculum; D, right pleopod 3; E, left pleopod 4; F, left pleopod 5.

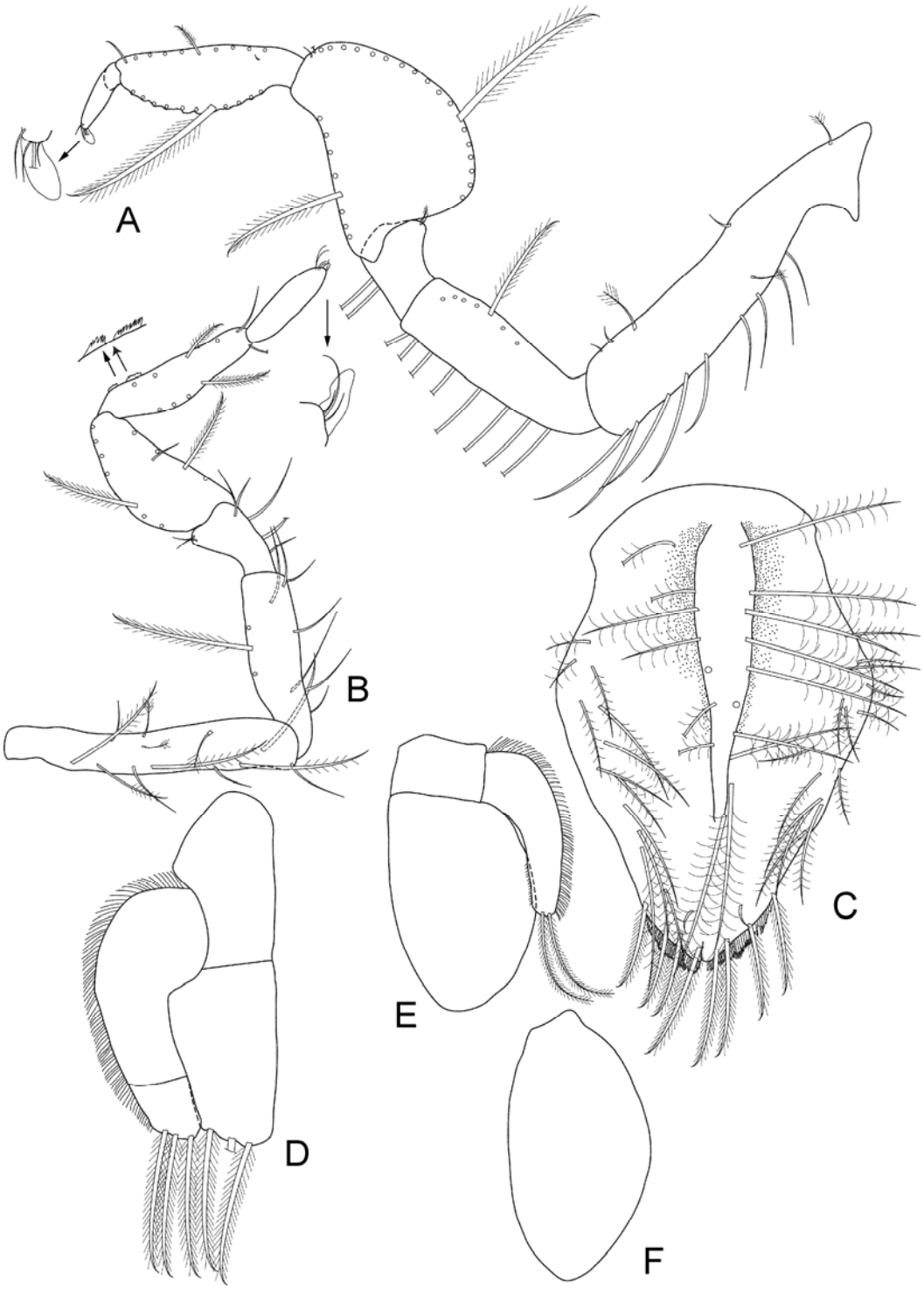
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Figure 5.1 Strict consensus tree found from the successively weighted analysis of the *Ilyarachna*-group in Chapter 3 showing general oceanic regional distributions.

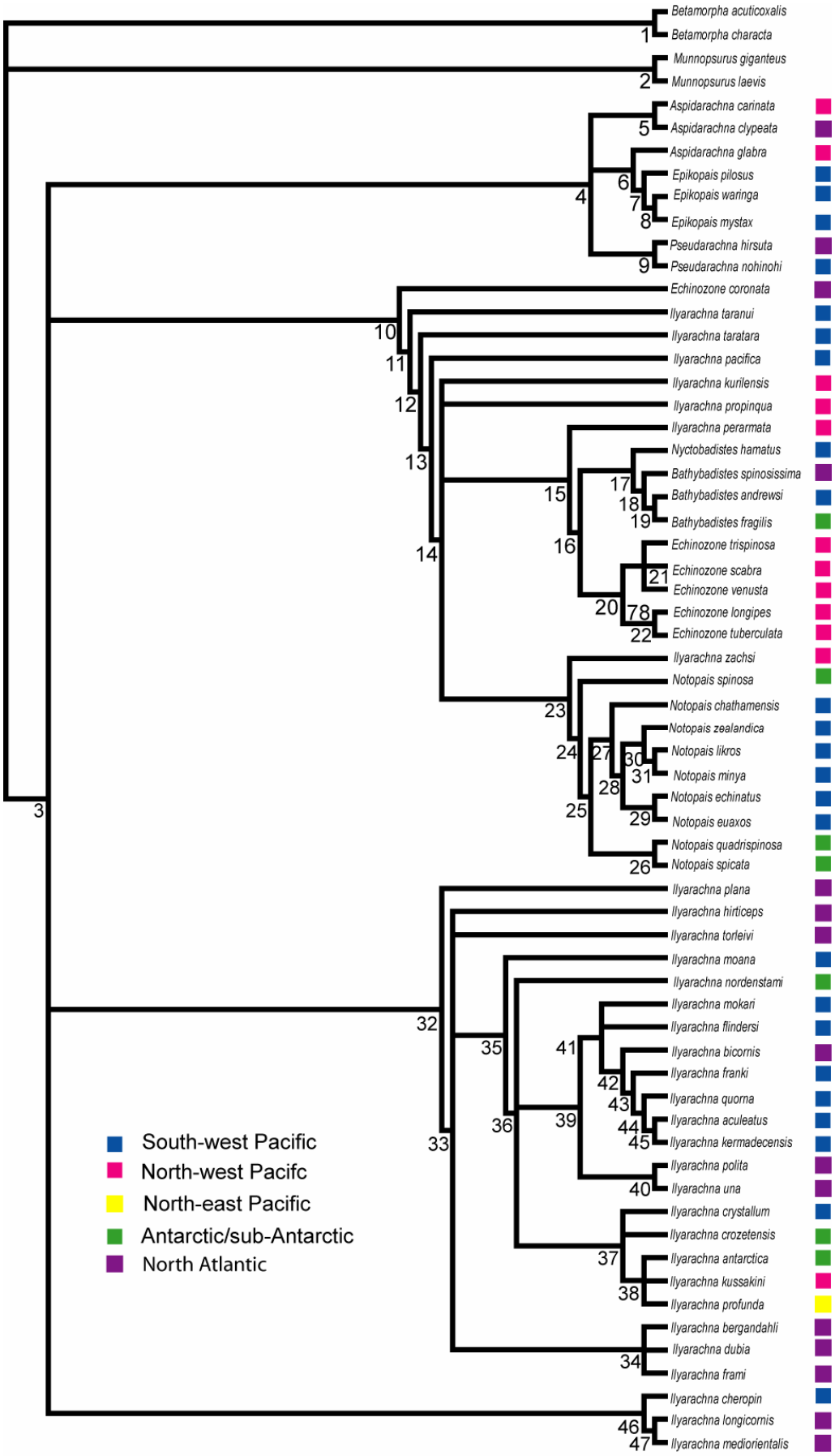
Betamorpha acuticoxalis
Betamorpha characta
Munnopsurus giganteus
Munnopsurus laevis
Aspidarachna carinata
Aspidarachna clypeata
Aspidarachna glabra
Epikopais pilosus
Epikopais waringa
Epikopais mystax
Pseudarachna hirsuta
Pseudarachna nohinohi
Echinozone coronata
Ilyarachna taranui
Ilyarachna taratara
Ilyarachna pacifica
Ilyarachna kurilensis
Ilyarachna propinqua
Ilyarachna perarmata
Nyctobadistes hamatus
Bathybadistes spinosissima
Bathybadistes andrewsi
Bathybadistes fragilis
Echinozone trispinosa
Echinozone scabra
Echinozone venusta
Echinozone longipes
Echinozone tuberculata
Ilyarachna zachsi
Notopais spinosa
Notopais chathamensis
Notopais zealandica
Notopais likros
Notopais minya
Notopais echinatus
Notopais euaxos
Notopais quadrispinosa
Notopais spicata
Ilyarachna plana
Ilyarachna hirticeps
Ilyarachna torleivi
Ilyarachna moana
Ilyarachna nordenstami
Ilyarachna mokari
Ilyarachna flindersi
Ilyarachna bicornis
Ilyarachna franki
Ilyarachna quorna
Ilyarachna aculeatus
Ilyarachna kermadecensis
Ilyarachna polita
Ilyarachna una
Ilyarachna crystallum
Ilyarachna crozetensis
Ilyarachna antarctica
Ilyarachna kussakini
Ilyarachna profunda
Ilyarachna bergandahli
Ilyarachna dubia
Ilyarachna frami
Ilyarachna cheropin
Ilyarachna longicornis
Ilyarachna mediorientalis
South-west Pacific
North-west Pacifc
North-east Pacific
Antarctic/sub-Antarctic
North Atlantic

Table 2.1: Character matrix as analysed in PAUP for the Munnopsidae.

Character number: 1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 12
Desmosoma hessleri 121--42111 121111212- -1-1121111 11-1211131 -1111-1311 1111212111 1111211111 11122212-1 21221?1-1 111-11--1? ?111111?21 41-222113- --
Eugerda gigantea 121--41211 121111212- -1-1121111 11-1211131 -1111-1311 1111212111 1111211111 11122212-1 1122111111 111-11--1? ?111111?21 41-2211121 12
Acanthamunnopsis hystrix 222--41111 1111112121 1441211132 1222131121 21111-1111 1111212141 1111211212 1211221232 21223313-1 131-11--11 2121111222 21-??2133- 1-
Acanthamunnopsis milleri 222--41111 1111112121 1441211132 1222131121 21111-1111 1111212141 1111211211 1211221232 21223313-1 131-1???11 2121111??? ?????2133- 1-
Acanthocope beddardi 2233-21111 1111221211 1442212131 1112331121 21111-2321 1111111111 1111211211 1111222211 11221111-1 2121122?21 -113121122 21-322133- 1-
Acanthocope unicornis 2233-21111 111111?2?1 1442212111 1112331121 21111-2321 1111111111 1111211211 2111222211 11221111-1 2121122221 -113121123 21-322133- 1-
Amuletta abyssorum 2233-21111 1111112111 1111111111 11-1131121 21111-1311 111112---- 1111211221 1211??1111 21??111111 111-121211 2111111113 1221211221 22
Aspidarachna clypeata 2231232111 1121111111 1111112111 11-1131111 21111-1112 2-21211111 1111211211 2311111111 1112113111 111-121111 2111111122 1221212-21 22
Baeonectes improvisus 221--11111 1111111111 1441112111 11-1131111 21111-1111 1111112121 1111212211 1111112121 2111111111 111-121211 2111111222 3222?11131 12
Baeonectes muticus 221--11111 1111111111 1441112111 11-1131111 21111-1111 1111112121 1121212211 1111112121 2111111111 111-121211 211111122? 32??11131 12
Bathybadistes andrewsi 2231232211 1113332311 1112212133 1321131121 2111212112 1211211211 1111211211 2311221111 1112113112 1321121111 3111111123 1221212-21 21
Bathybadistes fragilis 2231232211 1113331311 1112212144 1421131121 2111212112 1211211111 1111211211 2311221111 1112113112 1321121111 3111111123 1221212-21 21
Bathyopsurus nybelini 2233-21111 112111?1?2 11?1111111 11-1131121 11111-1111 1112-2---- 1121112212 ?111??1??2 2??????2?21 111-11--12 2112111??? ??????1??? ??

Bellibos (Bell) buzwilsoni 2233-21211 1111111121 1441122111 1111122131 -1121-1311 1111112111 2221212211 22111?1111 2112111111 111-121111 3112111122? 1??3?12-32 22
Bellibos (*Bell) dageti* 2233-21211 1111111111 1441122111 1121121131 -1121-1311 1111111111 2221211211 2111121111 1112111111 111-121111 3112111222 11-3?12-22 22
Bellibos (Bem) monicae 2233-21211 1111111121 1441111111 1121121131 -1121-1311 1111112111 2221211211 11112?1111 1112111111 111-121111 3112111122? 1??3?12-21 12
Belonecetes parvus 221--11111 1121112121 2231122111 11-1331221 21111-1111 1111112121 1111211211 ?111112111 2111112111 111-121111 2212111123 4212211131 12
Betamorpha acuticoxalis 2233-21111 1111111111 1111112111 11-1131131 -1111-1111 1111111111 1111211211 ?111111111 2112111111 111-121111 2111111212 11-1211211 22
Betamorpha characta 2233-21111 1111111111 1111112111 11-1131131 -1111-1111 1111111111 1111211211 ?111111111 2112111111 111-121111 2111111212 11-1211211 22
Coperonus comptus 2233-11111 1111111111 1111122111 21-1131111 11111-1311 1111112121 1111211211 1111112111 2211213111 111-121211 -211111122 21-2211131 22
Coperonus pulcher 2233-11111 1121112111 1111122111 21-1131111 21111-1311 1111112121 1111211211 1111112111 2311213111 111-121211 -111111122 31-2211131 22
Echinozone coronata 2231232111 1113331311 1111111141 1111131111 21111-1112 121122---- 1111211211 2311111111 1112113111 111-121111 3111111113 1222212-21 22
Echinozone longipes 2231232111 1111112121 1112121211 1121131121 21121-1112 2-1122---- 1111211221 1311221111 1122113111 121-121111 2111111123 1221222-2- 2-
Echinozone venusta 2231232211 1113332311 1112111244 1321131121 21121-1112 121122---- 1111211221 1311221111 1122113111 121-121111 2111111213 1221222-2- 2-
Eurycope cornuta 211--11111 1121111111 1111111111 11-1131111 11111-1111 1111112121 1111231211 1111112111 2112111111 111-121111 2111111223 4222211132 12
Eurycope magna 211--?1111 1111111111 1112111111 11-1131121 21111-1111 1111112111 1111211221 1111111111 ?1??111111 111-221111 3111211112 122??11331 12
Disconectes furcatus 211--?1112 1121111111 1231122111 11-1331?21 21111-1111 1111112121 1111211211 1111112111 2111111111 111-121211 2111111222 41-2211131 12

Disconectes phalangium 211--21112 1121111111 1231111111 11-1331221 21111-1111 1111112121 1111211211 1111112111 2112111111 111-121111 2111111222 41-2211131 12
Eurycope sandersi 211--11111 1121111111 1111112111 11-1331111 11111-1111 1111112122 1111131211 1111112111 1111111111 111-121111 2211111223 4222211131 22
Hapsidohedra ochlera 224--11111 1111111111 1321121111 21-1131111 21111-1311 1211112121 1111212211 2111111111 1112113111 111-121111 -111111122 21-2222-2- 2-
Ilyarachna longicornis 2231232111 1111111111 1111111111 11-1131111 21111-1112 1211211111 1111211211 2311111111 1112113111 111-121111 2111112222 1221212-21 21
Ilyarachna hirticeps 2231232111 1111111111 1111111111 11-1131111 21111-1112 1211211111 1111211211 2311111111 1112113111 111-121111 211111??22 1221212-21 21
Lionectes humicephalotus 224--11111 1111112121 1321121111 21-1131111 22111-1311 1111112121 1111212211 2111111111 1211213111 111-121211 -211111?22 21-2211121 22
Lipomera (Para) knorrae 224--11111 1113332311 1321122141 2111131121 21111-1311 1111112111 1111112211 1111111111 1111114-11 111-121211 -211111222 21-2132-- - --
Lipomera (Tetra) curvintestinata 224--11111 1111112111 1321122111 21-1131111 21111-1311 1111112111 1111212211 1111111111 1211114-11 111-121211 -211111122 21-2232--- --
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Microprotus caecus 2232-21111 1112332321 1442211244 1412131221 1211222221 1111112132 11?1221211 1122--1--1 21--1111-1 232212??11 1111111113 122??11332 22
Mimocopelates anchibraziliensi 2233-11111 1111111111 1111122111 21-1131111 22111-1311 1111112121 1111112211 ?111112111 2311214-11 111-221211 -211111123 21-212113- 1-
Mimocopelates longipes 2233-11111 1121112121 1111122111 21-1131111 22111-1311 1111112121 2 1111112211 1111122111 2311214-11 111-221111 -211111122 21-2211131 11
Munneurycope incisa 2233-41111 1111112121 1111111111 11-1131121 21111-1111 1111112122 1111211212 ?111112111 2112221211 111-1???11 2112111222 4???11231 ??
Munneurycope murrayi 2233-41111 1111112121 1111111111 11-1131121 21121-1111 1111112122 1111211212 1111112111 2112221211 111-11--12 3112111123 4222111231 11

Munnicope calyptra 2233-41111 1111112121 1112111111 11-1131121 22111-1111 1111112111 11?1211?1 ?111??1111 11??111111 111-2???11 3111211112 1????11331 12
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Munnopsurus laevis 2233-11111 1111112111 1111111111 11-1131121 11111-1112 1211111111 1111211212 ?111111111 1112111111 111-12??11 21111111?? ?????11231 22
Notopais echinatus 2231132211 1113331311 1111111144 1421131121 2111231112 2-2122---- 1111211211 2311111111 1112113111 111-121111 2111111113 1221212-21 22
Notopais spicata 2231132211 1113331311 1111111141 1121131121 2111232112 121122---- 1111211211 2311221111 1122113111 111-221111 2111111112 1221212-21 22
Notopais spinosa 2231132211 1113331311 1111111143 1321131121 2111231112 121122---- 1111211221 1311221111 1112113111 111-121111 2111111112 1221212-21 22
Paramunnopsis justi 222--41111 2111112121 1141111111 11-1131121 21111-1111 1111212141 1111211211 ?211??12?1 11??3313-1 111-11--11 ?121112223 21-1111331 11
Paramunnopsis oceanica 222--41111 1111112121 1141111111 11-1131121 21111-1111 1111212142 1111211211 1211221221 11223313-1 111-221211 2121112222? ?????2133- 1-
Paropsurus giganteus 2233-21111 1221112122 11?1111111 11-1131121 -1121-1111 1112-2---- 1121211212 1111??1??2 2??????2?21 111-221212 3111111222 122??11231 22

Paropsurus pellucidus 2233-21111 1221112122 1141111111 11-1131121 21121-1111 1112-2---- 1121211212 ?111??1??2 1??????21 111-2???12 ?112211123 122???1??? ??
Pseudarachna hirsuta 2231232111 1113332311 1111111111 1121131111 21111-1112 2-2122---- 1111211211 2311221111 1122113111 111-121111 ?11111??22 2221222-2- 2 2-
Pseudomunnopsis beddardi 222--41111 2211112121 1141121111 11-1331122 21111-1112 1212-2---- 1122211211 1211221231 11223313-1 111-22??11 2122211112? ?????2123- 1-
Rectisura richardsonae 2232-21111 1112222211 1142212133 1311131121 12111-1221 1111112132 1111221212 1111111111 21221111-1 232312??11 2111111113 1222111331 12
Rectisura serrata 2232-21111 1111222211 114221?133 1311131121 21111-1221 1111112132 111122121? ??11??1111 ?1221111-1 2323?2??11 ?111111?23 1222111331 12
Storthyngura elegans 2232-21111 1111222211 1442212111 1111132121 2111211221 1111112132 1111211211 1111?21121 21?21111-1 2122121111 ?111111?23 1222211331 12
Storthyngura kussakini 2232-21111 1112221211 1442212133 1311132121 21111-1221 1111112132 2 1111221211 11112212-11 1221111-1 2123121211 2111111212 1221111331 12
Storthyngura parka 2232-21111 1111221211 1442212132 1211132121 2111211221 1111112132 1111211211 1111111111 21121111-1 2322121211 ?111111?22 1222211331 3 12
Storthyngura phyllosoma 2232-21111 1112221211 1442111133 1311132121 2111211221 1111112132 1111211211 1122--1--1 11--1111-1 132321--1? ?111111213 1222211331 12
Storthyngurella hirsuta 2232-21211 1112332311 1442211233 1312132121 2111221221 1111112131 1111221211 11112212-1 11221111-1 2321121212 2111111213 1221211331 22
Storthyngurella menziesi 2232-21211 1113332311 1442212233 1311132121 2211221221 1111112132 1111211211 ?122--1--1 11--1111-1 2321121212 2111111223 1222111331 22
Storthyngurella triplispinosa 2232-21211 1113332311 1442211133 1311132121 1111221221 111111213? 2 111121121? ?122--1--1 11--1111-1 23212???12 2111111223 1222211331 22
Sursumura aberrata 2232-21211 1112222211 1442112133 1311132121 1211211221 1111112132 1111211211 1111??1111 11??1111-1 2321122211 ?111111?13 1222111331 ?2

Sursumura spinosissima 2232-21211 1112222211 1442212133 1311132121 1111211221 1111112132 1111211211 1111221111 11221111-1 2321122211 2111111113 1221111331 12
Syneurycope heezeni 2233-21121 1-11112121 1441111111 11-1121131 -1121-1311 1111111211 2221211211 1211221111 1122111111 111-121111 111111???? ?????12-21 22
Syneurycope parallela 2233-21121 1-11112121 1441111111 11-1121131 -1121-1311 1111111111 2221211211 2211221111 1122111111 111-121111 111111122? ?????12-21 22
Tytthocope megalura 211--21111 1111112111 3231111111 21-1131211 21111-1111 1111112121 1111211211 1111112111 1111112111 111-21--11 2111111122 2222111131 12
Vanhoeffenura bicornis 2232-21211 1112221211 1142212133 1311131121 21211-1221 1111112132 111122121? ??1111?111 ?1121111-1 1321122211 2111111113 1211?11231 12
Vanhoeffenura georgei 2232-21111 1111221211 1141112131 1111131121 22211-1221 1111112132 1111221212 1211111111 21121111-1 1121121211 2111111113 1211111231 12
Vanhoeffenura moskalevi 2232-21111 1111221211 1142212133 1311131121 22211-1221 1111112132 1111221211 ?111111111 21121111-1 1321122211 2112111113 1211111231 2 12
Vanhoeffenura myriamae 2232-21111 1111221211 1142212133 1311131121 22211-1221 1111112131 111122121? ?111111111 11121111-1 2321122211 ?11?111?13 1211211231 2 22

Table 2.2 Weights after successive weighting and consistency indices for the characters from both the full (analysis 2) and modified datasets (analysis 4) used in the analysis of the Munnopsidae. Grey boxes indicate those characters which were not used in analysis 4.

character number	**weight after reweighting**		**CI unweighted/weighted**	
	Analysis 2 full dataset	Analysis 4 modified dataset	Analysis 2 full dataset	Analysis 4 modified dataset
1	1.00	1.00	1.0/1.0	1.0/1.0
2	0.20	0.20	0.333/0.333	0.25/0.333
3	0.54	0.54	0.6/0.6	0.5/0.6
4	1.00	1.00	1.0/1.0	1.0/1.0
5	0.25	1.00	1.0/0.5	1.0/1.0
6	0.38	0.38	0.375/0.429	0.375/0.429
7	0.46	0.46	0.5/0.5	0.5/0.5
8	0.06		0.111/0.111	
9	1.00	1.00	1.0/1.0	1.0/1.0
10	1.00	1.00	1.0/1.0	1.0/1.0
11	1.00	1.00	0.5/1.0	0.5/1.0
12	0.14	0.14	0.25/0.25	0.25/0.25
13	0.08	0.08	0.167/0.167	0.143/0.167
14	0.26		0.286/0.333	
15	0.35		0.333/0.4	
16	0.35		0.333/0.4	
17	0.03	0.03	0.067/0.063	0.063/0.063
18	0.46		0.4/0.5	
19	0.06	0.06	0.091/0.1	0.091/0.1
20	1.00	1.00	1.0/1.0	1.0/1.0
21	1.00	1.00	1.0/1.0	1.0/1.0
22	0.44		0.429/0.5	
23	0.73	0.73	0.6/0.75	0.429/0.75
24	0.17	0.17	0.2/0.2	0.2/0.2
25	0.12	0.12	0.167/0.167	0.167/0.167
26	0.09	0.07	0.143/0.143	0.143/0.125
27	0.05	0.04	0.077/0.077	0.077/0.071
28	0.00	0.17	0.25/0.2	0.25/0.333
29	0.23		0.222/0.286	
30	0.23		0.3/0.333	
31	0.44	0.44	0.5/0.5	0.5/0.5
32	0.23		0.3/0.333	
33	0.13	0.27	0.25/0.2	0.25/0.333
34	0.22	0.22	0.25/0.333	0.333/0.333
35	0.21	0.21	0.333/0.333	0.333/0.333
36	1.00	1.00	1.0/1.0	1.0/1.0
37	0.17	0.17	0.25/0.25	0.25/0.25
38	0.33	0.33	0.5/0.5	0.25/0.5

39	0.13	0.15	0.2/0.2	0.2/0.22
40	1.00	1.00	1.0/1.0	1.0/1.0
41	0.03	0.05	0.125/0.111	0.125/0.125
42	0.04	0.04	0.125/0.125	0.125/0.125
43	1.00	1.00	1.0/1.0	1.0/1.0
44	0.11	0.17	0.25/0.2	0.25/0.25
45	0.10	0.29	0.25/0.167	0.25/0.333
46	1.00	1.00	1.0/1.0	1.0/1.0
47	0.13	0.13	0.25/0.25	0.25/0.25
48	0.36	0.36	0.4/0.4	0.4/0.4
49	1.00	1.00	1.0/1.0	1.0/1.0
50	0.30	0.47	0.5/0.333	0.5/0.5
51	0.00	0.00	0.167/0.143	0.167/0.143
52	0.28	0.28	0.333/0.333	0.333/0.333
53	0.00	0.00	0.2/0.167	0.2/0.167
54	0.43	0.43	0.5/0.5	0.5/0.5
55	0.47	0.47	0.5/0.5	0.5/0.5
56	0.14	0.10	0.167/0.2	0.143/0.167
57	0.10	0.28	0.25/0.167	0.25/0.333
58	0.00	0.00	0.5/0.5	0.5/0.5
59	0.46	0.57	0.5/0.5	0.5/0.6
60	0.10	0.10	0.143/0.143	0.143/0.143
61	1.00	1.00	1.0/1.0	1.0/1.0
62	1.00	1.00	1.0/1.0	1.0/1.0
63	0.14	0.20	0.2/0.2	0.2/0.25
64	1.00	1.00	1.0/1.0	1.0/1.0
65	0.06	0.06	0.25/0.25	0.25/0.25
66	0.40	0.40	0.4/0.5	0.5/0.5
67	0.17	0.11	0.2/0.25	0.2/0.2
68	1.00	1.00	1.0/1.0	1.0/1.0
69	0.00	0.03	0.2/0.143	0.2/0.167
70	0.06	0.06	0.143/0.143	0.143/0.143
71	0.04	0.04	0.111/0.1	0.111/0.1
72	0.23	0.23	0.286/0.286	0.286/0.286
73	0.38	0.38	0.5/0.5	0.5/0.5
74	0.22	0.22	0.333/0.333	0.333/0.333
75	0.17	0.13	0.2/0.2	0.2/0.167
76	0.17	0.17	0.2/0.2	0.2/0.2
77	0.20	0.29	0.25/0.25	0.25/0.333
78	0.29	0.46	0.333/0.333	0.5/0.5
79	0.14	0.14	0.333/0.333	0.333/0.333
80	0.38	0.38	0.5/0.5	0.5/0.5
81	0.03	0.04	0.077/0.067	0.083/0.077
82	0.10	0.25	0.4/0.4	0.4/0.5
83	0.10	0.12	0.167/0.143	0.167/0.167
84	0.19	0.19	0.25/0.25	0.25/0.25

85	0.43	0.32	0.333/0.5	0.333/0.4
86	1.00	0.60	0.667/1.0	0.667/0.667
87	0.43	0.43	0.667/0.5	0.429/0.5
88	1.00	0.60	0.667/1.0	0.667/0.667
89	1.00	1.00	1.0/1.0	1.0/1.0
90	1.00	1.00	1.0/1.0	1.0/1.0
91	0.20	0.15	0.2/0.25	0.2/0.2
92	0.21	0.26	0.333/0.286	0.333/0.333
93	0.48	0.48	0.5/0.5	0.5/0.5
94	0.11	0.11	0.333/0.333	0.333/0.333
95	0.04	0.04	0.111/0.1	0.111/0.1
96	0.02	0.02	0.167/0.143	0.167/0.143
97	0.13	0.22	0.25/0.25	0.25/0.333
98	0.09	0.09	0.125/0.125	0.111/0.125
99	1.00	1.00	1.0/1.0	1.0/1.0
100	0.13	0.13	0.25/0.25	0.25/0.25
101	0.10	0.10	0.222/0.222	0.222/0.222
102	0.14	0.14	0.2/0.25	0.2/0.25
103	1.00	1.00	1.0/1.0	1.0/1.0
104	0.08	0.08	0.222/0.222	0.222/0.222
105	0.06	0.06	0.25/0.25	0.25/0.25
106	1.00	1.00	1.0/1.0	1.0/1.0
107	0.07	0.07	0.167/0.2	0.167/0.2
108	0.04	0.03	0.071/0.071	0.067/0.067
109	0.13	0.05	0.111/0.167	0.091/0.091
110	0.06	0.06	0.118/0.125	0.118/0.125
111	0.16	0.16	0.231/0.25	0.231/0.25
112	0.12	0.10	0.167/0.167	0.167/0.143
113	0.38	0.38	0.5/0.5	0.5/0.5
114	0.14	0.16	0.2/0.2	0.2/0.222
115	0.03	0.03	0.1/0.1	0.1/0.1
116	0.10	0.16	0.25/0.2	0.25/0.25
117	0.30	0.30	0.25/0.333	0.25/0.333
118	0.28	0.28	0.4/0.333	0.4/0.333
119	0.21	0.27	0.286/0.286	0.286/0.333
120	0.17	0.06	0.333/0.333	0.333/0.25
121	0.06	0.08	0.1/0.091	0.091/0.111
122	0.07	0.07	0.2/0.2	0.2/0.2

Table 2.3. Character states defining clades or a terminal taxon in the strict consensus tree for the unmodified dataset, for both analysis 1 and analysis 2 (Figs 2.8, 2.9, 2.12–2.16). Those characters with a superscript 1 refer to a transformation from state 2 to 1 and those with a superscript 2 refer to a transformation from state 1 to 2. Characters in **bold** have a CI=1. Shading refers to that clade or taxon not defined in the respective analysis, diagonal lines refers to a species grouping with a different species than suggested in the opposing analysis.

Clade or terminal taxon	**Defining characters – Analysis 1**	**Defining characters – Analysis 2**
Desmosoma hessleri	7^{2}, 81^{2}, 116^{2}	7^{2}, 81^{2}, 116^{2}
Eugerda gigantea	8^{2}, $119^{3>2}$	8^{2}, $119^{3>2}$
1 – Munnopsidae	$\mathbf{1^{2}}$, 3^{2}, 12^{1}, 26^{1}, 35^{1}, $\mathbf{36^{1>3}}$, $39^{3>.2}$, $\mathbf{68^{2}}$, 74^{1}, 110^{2}, $111^{4>1}$, $118^{1>3}$	$\mathbf{1^{2}}$, 3^{2}, 12^{1}, 26^{1}, 35^{1}, $\mathbf{36^{1>3}}$, $39^{3>.2}$, $48^{3>1}$, $\mathbf{68^{2}}$, 74^{1}, 96^{2}, 110^{2}, $111^{4>1}$, 114^{1}, $118^{1>3}$
2 – Munnopsinae	$48^{3>1}$, $59^{1>4}$, 72^{2}, 79^{2}, $85^{1>3}$, $86^{1>3}$, $88^{1>3}$, $\mathbf{103^{2}}$, 107^{2}, 108^{2}, 111^{2}, 114^{1}, 115^{1}, 116^{2}, 122^{1}	$59^{1>4}$, 72^{2}, 79^{2}, $85^{1>3}$, $\mathbf{86^{1>3}}$, $\mathbf{88^{1>3}}$, $\mathbf{103^{2}}$, 108^{2}, 111^{2}, 115^{1}, 116^{2}, 122^{1}
3 – *Acanthamunnopsis*	$22^{1>4}$, 25^{2}, $29^{1>3}$, 30^{2}, 32^{2}, 33^{2}, 34^{2}, $79^{2>3}$, 80^{2}, 81^{2}, $92^{1>3}$, 107^{1}	$22^{1>4}$, 25^{2}, $29^{1>3}$, 30^{2}, 32^{2}, 33^{2}, 34^{2}, $79^{2>3}$, 80^{2}, 81^{2}, $92^{1>3}$, 96^{1}
Acanthamunnopsis hystrix	70^{2}	70^{2}
A		95^{2}, 107^{2}, $110^{2>3}$
Paramunnopsis oceanea		60^{2}
B		$\mathbf{11^{2}}$
Paramunnopsis justi	11^{2}, $110^{2>3}$, 116^{1}	95^{1}, 96^{1}, 116^{1}
4	60^{2}, 95^{2}, 96^{2}, 111^{1}	
5	11^{2}, 12^{2}, $35^{1>3}$, $\mathbf{40^{2}}$, 50^{2}, 52^{2}, 54^{2}, 63^{2}, $\mathbf{64^{2}}$	12^{2}, $35^{1>3}$, $\mathbf{40^{2}}$, 50^{2}, 52^{2}, 54^{2}, 63^{2}, $\mathbf{64^{2}}$, 111^{1}
Munnopsis typica	8^{2}, 41^{1}, $110^{2>3}$, $111^{1>4}$	8^{2}, 41^{1}, 60^{2}, $111^{1>4}$
C		51^{2}, 53^{2}, $59^{4>1}$, 69^{2}, 79^{1}, $110^{3>2}$, 112^{2}
6	51^{2}, 53^{2}, $59^{4>1}$, 60^{1} 69^{2}, 70^{2} 79^{1}, 112^{2}	
Munnopsis longiremus	91^{2}, $101^{2>3}$, 104^{2}, 105^{2}, 107^{1}, 108^{1}, 121^{2}	91^{2}, $101^{2>3}$, 104^{2}, 105^{2}, 107^{1}, 108^{1}, 121^{2}
D		56^{2}
Munnopsis bathyalis	56^{2}, 95^{1}	70^{2}, 95^{1}
7	26^{2}, 56^{2}, $79^{2>3}$, $118^{3>2}$	26^{2}, 51^{1}, 53^{1}, 69^{1}, $79^{1>3}$, $118^{3>2}$
Munnopsis eximius	12^{1}, 71^{2}	12^{1}, 71^{2}
Pseudomunnopsis beddardi	104^{2}, 105^{2}, 107^{1}, 108^{1}	104^{2}, 105^{2}, 107^{1}, 108^{1}

8	$3^{2>3}$, $6^{4>2}$, 19^{1} $22^{1>4}$ 55^{1}, 78^{1}, 96^{2}	$3^{2>3}$, $6^{4>2}$, 55^{1}, 78^{1}, 121^{2}
9	15^{2}, 16^{2}, 18^{2}, 24^{2}, 25^{2}, 27^{2}, $\mathbf{49^{2}}$, 91^{2}, 93^{2}, $110^{2>3}$	15^{2}, 16^{2}, 18^{2}, 19^{1}, 24^{2}, 25^{2}, 27^{2}, $\mathbf{49^{2}}$, 91^{2}, 93^{2}, $110^{2>3}$, 121^{1}
E		$22^{1>4}$, $48^{1>3}$, $114^{1>3}$
10 – Acanthocopinae / *Acanthocope*	17^{1}, 34^{2}, $35^{1>3}$, 47^{2}, 57^{1}, 77^{2}, 78^{2}, 97^{2}, $\mathbf{99^{2}}$, $104^{1>3}$, $\mathbf{106^{2}}$, 111^{2}, $114^{2>3}$, 116^{2}	17^{1}, 34^{2}, $35^{1>3}$, 47^{2}, 57^{1}, 77^{2}, 78^{2}, 97^{2}, $\mathbf{99^{2}}$, $104^{1>3}$, $\mathbf{106^{2}}$, 111^{2}, 116^{2}
Acanthocope beddardi	$29^{1>3}$, $110^{3>2}$	$29^{1>3}$, $110^{3>2}$
Acanthocope unicornis	15^{1}, 16^{1}, 71^{2}	15^{1}, 16^{1}, 71^{2}
11- Storthyngurinae	$\mathbf{4^{3>2}}$, 37^{2}, 45^{2}, $48^{3>2}$, $59^{1>3}$, 60^{2}, 81^{2}, 94^{2}, 112^{2}	$\mathbf{4^{3>2}}$, 37^{2}, 45^{2}, $48^{3>2}$, $59^{1>3}$, 60^{2}, 81^{2}, 94^{2}, 112^{2}, $114^{3>2}$
Storthyngura elegans	79^{2}, 98^{1}	79^{2}, 98^{1}
12	$29^{1>3}$, $30^{1>3}$, $32^{1>3}$, $92^{1>3}$, $94^{2>3}$, 115^{1}	$29^{1>3}$, $30^{1>3}$, $32^{1>3}$, $92^{1>3}$, $94^{2>3}$, 115^{1}
13	14^{2}, 81^{1}, 109^{1}	14^{2}, 81^{1}, 109^{1}
14 - *Sursumura*	8^{2}, 41^{1}, $94^{3>1}$, 97^{2}	8^{2}, 41^{1}, $94^{3>1}$, 97^{2}
Sursumura aberrata	25^{1}, 42^{2}	25^{1}, 42^{2}
Sursumura spinosissima	114^{1}	114^{1}
15	66^{2}, 78^{2}, 108^{2}	78^{2}, 108^{2}
Storthyngura kussakini	45^{1}, $92^{3>1}$, $110^{3>2}$, 114^{1}	45^{1}, 66^{2}, $92^{3>1}$, $110^{3>2}$, 114^{1}
16	27^{1}, 73^{2}, 74^{2}, 100^{2}, 115^{2}	27^{1}, 73^{2}, 74^{2}, 100^{2}, 115^{2}
Storthyngura phyllosoma	17^{1}, 25^{1}, 66^{1}, 91^{1}, 95^{2}, 96^{1}	17^{1}, 25^{1}, 91^{1}, 95^{2}, 96^{1}
17	8^{2}, $15^{2>3}$, $16^{2>3}$, $18^{2>3}$, 28^{2}, 34^{2}, $\mathbf{46^{2}}$, $94^{3>1}$, 121^{2}	8^{2}, $15^{2>3}$, $16^{2>3}$, $18^{2>3}$, 28^{2}, $\mathbf{46^{2}}$, $94^{3>1}$, 121^{2}
18	$14^{2>3}$, 34^{1}, 66^{1}, 109^{2}	$14^{2>3}$, 109^{2}
Storthyngurella menziesi	27^{2}, 42^{2}, 115^{1}	27^{2}, 42^{2}, 115^{1}
Storthyngurella triplispinosa	28^{1}, 95^{2}	28^{1}, 95^{2}
F		34^{2}, 66^{2}, 114^{1}
Storthyngurella hirsuta	60^{1}, 73^{1}, 74^{1}, 114^{1}	60^{1}, 73^{1}, 74^{1}
19 - *Microprotus*	8^{1}, 19^{2}, $29^{3>4}$, $30^{3>4}$, $32^{3>4}$, 37^{1}, 38^{2}, 41^{1}, 42^{2}, 47^{2}, 63^{2}, 81^{2}, 94^{2}, 100^{1}, 101^{1}, 108^{1}, 120^{2}	8^{1}, 19^{2}, $29^{3>4}$, $30^{3>4}$, $32^{3>4}$, 37^{1}, 38^{2}, 41^{1}, 42^{2}, 47^{2}, 63^{2}, 81^{2}, 94^{2}, 100^{1}, 101^{1}, 108^{1}, 120^{2}
Microprotus acutispinatus	28^{1}, 72^{2}	28^{1}, 72^{2}
20	75^{1}, 76^{1}	75^{1}, 76^{1}
Storthyngura parka	17^{1}, $30^{3>2}$, $32^{3>2}$, 83^{1}, $110^{3>2}$, 115^{2}	17^{1}, $30^{3>2}$, $32^{3>2}$, 83^{1}, $110^{3>2}$, 115^{2}
21	$22^{4>1}$, 37^{1}, 45^{1}, 66^{2}, 70^{2}, 97^{2}	$22^{4>1}$, 37^{1}, 45^{1}, 66^{2}, 70^{2}, 97^{2}
22	42^{2}, 109^{1}	42^{2}, 109^{1}

Rectisura richardsonae	14^{2}, 41^{1}	14^{2}, 41^{1}
23 - *Vanhoeffenura*	17^{1}, $\mathbf{43^{2}}$, 83^{1}, 91^{1}, $94^{3>1}$, 113^{1}, 114^{1}, $118^{3>2}$	17^{1}, $\mathbf{43^{2}}$, 83^{1}, $94^{3>1}$, 113^{1}, 114^{1}, $118^{3>2}$
Vanhoeffenura myriamae	60^{1}, 81^{1}, 91^{2}, 115^{2}, 121^{2}	60^{1}, 81^{1}, 115^{2}, 121^{2}
G		91^{1}
Vanhoeffenura bicornis	8^{2}, 14^{2}, 42^{1}	8^{2}, 14^{2}, 42^{1}
Vanhoeffenura georgei	24^{1}, 25^{1}, $30^{3>1}$, $32^{3>1}$, 72^{2}, $92^{3>1}$, 97^{1}	24^{1}, 25^{1}, $30^{3>1}$, $32^{3>1}$, 72^{2}, $92^{3>1}$, 97^{1}
Vanhoeffenura moskalevi	70^{1}, 104^{2}	70^{1}, 104^{2}
24	$22^{4>1}$, $23^{4>1}$, $48^{3>1}$, 75^{1}, 76^{1}, 83^{1}, 112^{2}	75^{1}, 76^{1}, 81^{2}, 83^{1}, 112^{2}, $118^{3>2}$
25	59^{2}, 81^{2}, $118^{3>2}$, 121^{2}	
H		19^{1}, $23^{4>1}$
I		69^{2}, 109^{1}
Amuletta abyssorum	$48^{1>3}$, 56^{2}, 69^{2}, 72^{2}, 109^{1}, $110^{2>3}$, 114^{1}, $119^{3>2}$	$48^{1>3}$, 56^{2}, 72^{2}, $110^{2>3}$, $119^{3>2}$
26	17^{1}, 57^{1}, 59^{1}, 98^{1}, 114^{1}	
J		17^{1}, 28^{1}
27 - *Betamorpha*	27^{2}, $39^{2>3}$, 109^{1}, 112^{1}, $119^{3>1}$	27^{2}, $39^{2>3}$, 57^{1}, 69^{1}, 112^{1}, $119^{3>1}$
Betamorpha characta	108^{2}	108^{2}
28	6^{1}, 50^{2}, 52^{2}, 81^{1}	
K		6^{1}
L		33^{2}, 50^{2}, 52^{2}, 57^{1}, 71^{2}, 81^{1}, 98^{1}
29 - *Munnopsurus*	41^{1}, 70^{2}, $110^{2>3}$, 111^{2}	
Munnopsurus laevis	17^{2}	41^{1}, 70^{2}
Munnopsurus giganteus (analysis 1 only)	51^{2}, 53^{2}, 85^{2}, 86^{2}, 88^{2}	
30 - Ilyarachninae	$\mathbf{4^{3>1}}$, $6^{1>3}$, 7^{2}, 39^{1}, 55^{2}, 71^{2}, $72^{1>3}$, $87^{1>3}$, 117^{2}, $119^{3>2}$	$\mathbf{4^{3>1}}$, $6^{1>3}$, 7^{2}, 51^{2}, 55^{2}, $72^{1>3}$, $87^{1>3}$, 117^{2}, $119^{3>2}$
M		17^{1} 39^{1}
Aspidarachna clypeata	13^{2}, 27^{2}, 51^{2}, 53^{2}	13^{2}, 27^{2}, 53^{2}
31 - *Ilyarachna*	107^{2}, 108^{2}, 122^{1}	51^{1}, 107^{2}, 108^{2}, 122^{1}
32	$14^{1>3}$, $15^{1>3}$, $16^{1>3}$, $18^{1>3}$, $29^{1>4}$, 56^{2}, $110^{2>3}$	56^{2}, 75^{2}, 76^{2}, 83^{2}, 116^{2}
Echinozone coronata (analysis 1 only)	$101^{2>3}$, 109^{1}, 114^{2}	
Echinozone longipes (analysis 2 only)		19^{2}, 24^{2}, 26^{2}, 28^{2}, 44^{2}, 69^{2} 71^{1}, 92^{2}, $110^{2>3}$
33	33^{2}, 39^{2}, 75^{2}, 76^{2}	
34	17^{2}, $29^{4>1}$, 51^{2}, 83^{2}, 116^{2}	
N		$14^{1>3}$, $15^{1>3}$, $16^{1>3}$, $18^{1>3}$
Pseudarachna hirsuta	39^{1}, 53^{2}, $110^{3>2}$, 111^{2}	39^{1}, 53^{2}, 111^{2}

35 – *Echinozone*	24^{2}, 28^{2}, 44^{2}, 69^{2}, 71^{1}, 92^{2}	
Echinozone longipes (analysis 1 only)	$14^{3>1}$, $15^{3>1}$, $16^{3>1}$, $18^{3>1}$, 19^{2}, 26^{2}	
Echinozone venusta (analysis 1 only)	8^{2}, $29^{1>4}$, $30^{1>4}$, $32^{1>3}$, 51^{1}, 108^{2}, 109^{1}	
36	8^{2}, $30^{1>3}$, $32^{1>3}$, 45^{2}	
37 - *Notopais*	$\mathbf{5^{1}}$, $\mathbf{46^{1>3}}$, 109^{1}	
Notopais echinatus (analysis 1 only)	$30^{3>4}$, $32^{3>4}$, 51^{2}, 53^{2}, 75^{1}, 76^{1}	
38	$110^{3>2}$	
O		8^{2}, $29^{1>4}$, 45^{2}, 51^{1}, 109^{1}, 116^{1}
P		5^{1}, 17^{1}, $\mathbf{46^{1>3}}$
Notopais spicata	$30^{3>1}$, $32^{3>1}$, 47^{2}, 83^{2}, 95^{2}	47^{2}, 95^{2}
Q		83^{1}
Notopais spinosa	69^{2}, 71^{1}	$30^{1>3}$, $32^{1>3}$, 69^{2}, 71^{1}
R		75^{1}, 76^{1}, $110^{2>3}$
Echinozone coronata (analysis 2 only)		5^{2}, 8^{1}, 33^{1}, 39^{1}, 45^{1}, $101^{2>3}$, 114^{2}
Notopais echinatus (analysis 2 only)		$30^{1>4}$, $32^{1>4}$, 51^{2}, 53^{2}
S		24^{2}, $30^{1>4}$, $32^{1>3}$, 92^{2}, $110^{2>3}$, 122^{1}
Echinozone venusta (analysis 2 only)		28^{2}, 44^{2}, 45^{1}, 69^{2}, 71^{1}, 108^{2}, 116^{2}
39 - *Bathybadistes*	24^{2}, 25^{2}, 27^{2}, 47^{2}, 56^{1}, $\mathbf{90^{2}}$, $92^{1>3}$, 93^{2}, $101^{2>3}$, 122^{1}	25^{2}, 27^{2}, 47^{2}, 56^{1}, 83^{1}, $\mathbf{90^{2}}$, $92^{2>3}$, 93^{2}, $101^{2>3}$, 109^{2}
Bathybadistes andrewsi	17^{2}, $29^{4>3}$, 58^{2}	$29^{4>3}$, $30^{4>3}$, 58^{2}
Bathybadistes fragilis	$30^{3>4}$, $32^{3>4}$	17^{1}, $32^{3>4}$
40	6^{1}, 27^{2}, 39^{1}, 77^{2}, 84^{1}, 111^{2}, 118^{1}	27^{2}, 39^{1}, 59^{2}, 77^{2}, 84^{1}, $111^{1>3}$, 114^{2}, 118^{1}
41 - Eurycopinae	$3^{3>1}$, 17^{1}, 108^{2} $111^{2>3}$, 121^{1}	$3^{3>1}$, 17^{1}, 108^{2}, 121^{1}
42 - *Baeonectes*	$22^{1>4}$, $23^{1>4}$, 67^{2}, 79^{2}	$22^{1>4}$, $23^{1>4}$, 67^{2}, 79^{2}
Baeonectes muticus	63^{2}	63^{2}
43	2^{1}, 13^{2}, $35^{1>3}$, 98^{1}, $111^{3>4}$	2^{1}, 13^{2}, $35^{1>3}$, 98^{1}, $111^{3>4}$
44 - *Eurycope*	41^{1}, $66^{1>3}$, $110^{2>3}$	41^{1}, $66^{1>3}$, $110^{2>3}$
Eurycope cornuta	27^{1}, $35^{3>1}$, 84^{2}, 120^{2}	27^{1}, $35^{3>1}$, 84^{2}, 120^{2}
Eurycope sandersi	60^{2}, 65^{1}, 81^{1}, 102^{2}, 121^{2}	60^{2}, 65^{1}, 81^{1}, 102^{2}, 121^{2}
45	6^{2}, 22^{2}, $23^{1>3}$, 38^{2}, 39^{2}	6^{2}, 22^{2}, $23^{1>3}$, 38^{2}, 39^{2}
46 - *Disconectes*	$\mathbf{10^{2}}$, 112^{1}	$\mathbf{10^{2}}$, 112^{1}
Disconectes furcatus	26^{2}, 98^{2}	26^{2}, 98^{2}
Disconectes phalangium	27^{1}, 84^{2}	27^{1}, 84^{2}
47	17^{2}, $\mathbf{21^{2}}$, 87^{2}, 108^{1}	17^{2}, $\mathbf{21^{2}}$, 87^{2}, 108^{1}

Belonectes parvus	2^{2}, 6^{1}, 19^{2}, 26^{2}, 102^{2}, 104^{2}, $110^{2>3}$, 113^{1}	2^{2}, 6^{1}, 19^{2}, 26^{2}, 102^{2}, 104^{2}, $110^{2>3}$, 113^{1}
Tytthocope megalura	13^{1}, $\mathbf{21^{2>3}}$, 27^{1}, 31^{2}, $35^{3>1}$, 39^{1}, 81^{1}, 95^{2}, 96^{1}, $111^{4>2}$, 115^{1}	13^{1}, $\mathbf{21^{2>3}}$, 27^{1}, 31^{2}, $35^{3>1}$, 39^{1}, 81^{1}, 95^{2}, 96^{1}, $111^{4>2}$, 115^{1}
48 - Lipomerinae	26^{2}, 31^{2}, $48^{1>3}$, 82^{2}, 85^{2}, $87^{1>3}$, 102^{2}, 112^{1}	26^{2}, 31^{2}, $48^{1>3}$, 82^{2}, 85^{2}, $87^{1>3}$, 112^{1}
Coperonus pulcher	13^{2}, $82^{2>3}$, 102^{1}, $111^{2>3}$	13^{2}, $82^{2>3}$
T		102^{2}, $111^{3>2}$
Coperonus comptus	17^{1}, 41^{1}	17^{1}, 41^{1}
U		42^{2}, 67^{2}
49 - *Mimcopelates*	42^{2}, 65^{1}, 67^{2}, $82^{2>3}$, $87^{3>4}$ 95^{2}, 121^{1}, 122^{1}	65^{1}, $82^{2>3}$, $87^{3>4}$ 95^{2}, 121^{1}, 122^{1}
Mimcopelates anchibraziliensis	17^{1}, $110^{2>3}$, 115^{1}, 116^{2}	17^{1}, $110^{2>3}$, 115^{1}, 116^{2}
Mimcopelates longipes	13^{2}, 19^{2}, 76^{2}, 98^{1}	13^{2}, 19^{2}, 76^{2}, 98^{1}
50	$3^{3>4}$, $22^{1>3}$, 23^{2}, 27^{1}, 67^{2}, 71^{2}, 77^{1}, 81^{1}, 85^{1}, 117^{2}, $119^{3>2}$	$3^{3>4}$, $22^{1>3}$, 23^{2}, 27^{1}, 71^{2}, 77^{1}, 81^{1}, $119^{3>2}$
Lionectes humicephalotus	19^{2}, 42^{2}, 85^{2}, 117^{1}	19^{2}
V		42^{1}, 82^{1}, 85^{1}, 116^{2}, 117^{2}
Hapsihohedra ochlera	17^{1}, 52^{2}, 82^{1}, 84^{2}, 98^{1}, 102^{1}, 116^{2}	17^{1}, 52^{2}, 84^{2}, 98^{1}, 102^{1}
51 - *Lipomera*	27^{2}, 59^{1}, 71^{1}, $87^{3>4}$, $116^{1>3}$	27^{2}, 59^{1}, 71^{1}, $87^{3>4}$, $116^{2>3}$
Lipomera (Paralipomera) knorrae	$14^{1>3}$, $15^{1>3}$, $16^{1>3}$, $18^{1>3}$, $29^{1>4}$, 39^{2}, 65^{1}, 82^{1}, 108^{2}, 115^{1}	$14^{1>3}$, $15^{1>3}$, $16^{1>3}$, $18^{1>3}$, $29^{1>4}$, 39^{2}, 65^{1}, 108^{2}, 115^{1}
Lipomera (Tetracope) curvintestinata		82^{2}
52 - Bathyopsurinae	13^{2}, 19^{2}, $\mathbf{20^{2}}$, $23^{1>4}$, 54^{2}, 56^{2}, 63^{2}, 70^{2}, 80^{2}, 87^{2}, $\mathbf{89^{2}}$, 100^{2}, 104^{2}	13^{2}, $\mathbf{20^{2}}$, 54^{2}, 56^{2}, 63^{2}, 70^{2}, 80^{2}, 87^{2}, $\mathbf{89^{2}}$, 100^{2}, 104^{2}
Bathyopsurus nybelini	41^{1}, 65^{1}, 67^{2}, 96^{1}	41^{1}, 65^{1}, 67^{2}, 96^{1}
53 - *Paropsurus*	12^{2}, 44^{2}, 95^{2}, $101^{2>3}$	12^{2}, 44^{2}, 95^{2}, $101^{2>3}$
Paropsurus giganteus	104^{1}, 108^{2}	104^{1}, 108^{2}
Paropsurus pellucidus	81^{1}, 105^{2}, $110^{2>3}$	81^{1}, 105^{2}, $110^{2>3}$
W		70^{2}, 85^{2}, $\mathbf{86^{2}}$, $\mathbf{88^{2}}$, $110^{2>3}$, 111^{2}
Munnopsurus giganteus (analysis 2 only)		17^{1}, 41^{1}, 50^{2}, 51^{2}, 53^{2}, 57^{1}, 81^{1}
54 - *Munneurycope*	$6^{2>4}$, 19^{2}, 60^{2}, 70^{2}, 77^{2}, 85^{2}, 86^{2}, 88^{2}, 96^{1}, 104^{2}, $110^{2>3}$, $111^{1>4}$, 115^{1}, 121^{1}, 122^{1}	$6^{1>4}$, 19^{2}, 59^{2}, 60^{2}, 77^{2}, 96^{1}, 104^{2}, $111^{2>4}$, 114^{2} 115^{1}, 121^{1}, 122^{1}
Munneurycope incisa	108^{2}	108^{2}

Munneurycope murrayi	44^{2}, 100^{2}, $101^{2>3}$	44^{2}, 100^{2}, $101^{2>3}$
55 (from clade J in analysis 2)	$6^{2>4}$, 24^{2}, 69^{2}, 95^{2}, 98^{1} $101^{2>3}$, 105^{2}, 109^{1}	$6^{2>4}$, 24^{2}, 81^{1}, 95^{2}, $101^{2>3}$, 105^{2}, $118^{2>3}$, 121^{1}
Eurycope magna	2^{1}, $3^{3>1}$, 17^{1}	2^{1}, $3^{3>1}$
Munnicope calyptra	19^{2}, 42^{2}	17^{2}, 19^{2}, 42^{2}
56 – Syneurycopinae (from clade E in analysis 2)	19^{2}, 33^{2}, $\mathbf{36^{3>2}}$, $39^{2>3}$, 44^{2}, $\mathbf{61^{2}}$, $\mathbf{62^{2}}$, 63^{2}, 98^{1}, 101^{1}, 108^{2}, $114^{2>3}$, 117^{2}, $119^{3>2}$, 121^{2}	33^{2}, $\mathbf{36^{3>2}}$, $39^{2>3}$, 44^{2}, $\mathbf{61^{2}}$, $\mathbf{62^{2}}$, 63^{2}, 98^{1}, 101^{1}, 108^{2}, 117^{2}, $119^{3>2}$
57 - *Syneurycope*	$\mathbf{9^{2}}$, 57^{1}, 72^{2}, 107^{2}	$\mathbf{9^{2}}$, 57^{1}, 72^{2}, 107^{2}
Syneurycope heezeni	58^{2}	58^{2}
Syneurycope parallela	71^{2}	71^{2}
58 - *Bellibos*	8^{2}, 17^{1}, 83^{1}, $101^{1>3}$, 104^{2}	8^{2}, 17^{1}, 83^{1}, $101^{1>3}$, 104^{2}
Bellibos (Bemerria*) monicae*	121^{1}	121^{1}
59 - *Bellibos (Bellibos)*	26^{2}, 27^{2}, 71^{2}, 75^{1}, 120^{2}	26^{2}, 27^{2}, 71^{2}, 75^{1}, 120^{2}
Bellibos (Bellibos) buzwilsoni	33^{1}, 37^{2}, 67^{2}, 72^{2}, 81^{2}, $119^{2>3}$	33^{1}, 37^{2}, 67^{2}, 72^{2}, 81^{2}, $119^{2>3}$
Bellibos (Bellibos) dageti	19^{1}, 57^{1}	19^{1}, 57^{1}

Table 2.4. Character states defining clades or a terminal taxon in the strict consensus tree for the modified dataset, for both analysis 3 (Fig. 2.10) and analysis 4 (Fig. 2.11). Those characters with a superscript 1 refer to a transformation from state 2 to 1 and those with a superscript 2 refer to a transformation from state 1 to 2. Characters in **bold** have a CI=1. Shading refers to that clade or taxon not defined in the respective analysis, diagonal lines refers to a species grouping with a different species than suggested in the opposing analysis.

Clade or terminal taxon	**Defining characters – Analysis 3**	**Defining characters – Analysis 4**
Desmosoma hessleri	7^{2}, 81^{2}, 116^{2}	7^{2}, 81^{2}, 116^{2}
Eugerda gigantea	$119^{3>2}$	$119^{3>2}$
1 - Munnopsidae	$\mathbf{1^{2}}$, 3^{2}, 12^{1}, 26^{1}, 35^{1}, $\mathbf{36^{1>3}}$, $39^{3>.2}$, $\mathbf{68^{2}}$, 74^{1}, 110^{2}, $111^{4>1}$, 114^{1}, $118^{1>3}$	$\mathbf{1^{2}}$, 3^{2}, 12^{1}, 26^{1}, 35^{1}, $\mathbf{36^{1>3}}$, $39^{3>.2}$, $\mathbf{68^{2}}$, 74^{1}, 96^{2}, 110^{2}, $111^{4>1}$, 114^{1}, $118^{1>3}$
2 - Munnopsinae	$48^{3>1}$, $59^{1>4}$, 72^{2}, 79^{2}, $85^{1>3}$, $86^{1>3}$, $88^{1>3}$, $\mathbf{103^{2}}$, 107^{2}, 111^{2}, 115^{1}, 116^{2}, 122^{1}	$48^{3>1}$, $59^{1>4}$, 72^{2}, 79^{2}, $85^{1>3}$, $86^{1>3}$, $88^{1>3}$, $\mathbf{103^{2}}$, 108^{2}, 111^{2}, 115^{1}, 116^{2}, 122^{1}
3 - *Acanthamunnopsis*	25^{2}, 33^{2}, 34^{2}, $79^{2>3}$, 80^{2}, 81^{2}, $92^{1>3}$, 107^{1}	25^{2}, 33^{2}, 34^{2}, $79^{2>3}$, 80^{2}, 81^{2}, $92^{1>3}$, 96^{1}
Acanthamunnopsis hystrix	70^{2}	70^{2}
A		95^{2}, 107^{2}, $110^{2>3}$
Paramunnopsis oceanea		60^{2}
B		$\mathbf{11^{2}}$
Paramunnopsis justi	11^{2}, $110^{2>3}$, 116^{1}	95^{1}, 96^{1}, 116^{1}
4	60^{2}, 95^{2}, 96^{2}, 111^{1}	
5	11^{2}, 12^{2}, $35^{1>3}$, $\mathbf{40^{2}}$, 50^{2}, 52^{2}, 54^{2}, 63^{2}, $\mathbf{64^{2}}$	12^{2}, $35^{1>3}$, $\mathbf{40^{2}}$, 50^{2}, 52^{2}, 54^{2}, 63^{2}, $\mathbf{64^{2}}$, 111^{1}
Munnopsis typica	41^{1}, $110^{2>3}$, $111^{1>4}$	41^{1}, 60^{2}, $111^{1>4}$
C		51^{2}, 53^{2}, $59^{4>1}$, 69^{2}, 79^{1}, $110^{3>2}$, 112^{2}
6	51^{2}, 53^{2}, $59^{4>1}$, 60^{1} 69^{2}, 70^{2} 79^{1}, 112^{2}	
Munnopsis longiremis	91^{2}, $101^{2>3}$, 104^{2}, 105^{2}, 107^{1}, 108^{1}, 121^{2}	91^{2}, $101^{2>3}$, 104^{2}, 105^{2}, 107^{1}, 108^{1}, 121^{2}
D		56^{2}
Munnopsis bathyalis	56^{2}, 95^{1}	70^{2}, 95^{1}
7	26^{2}, 56^{2}, $79^{2>3}$, $118^{3>2}$	26^{2}, 51^{1}, 53^{1}, 69^{1}, $79^{1>3}$, $118^{3>2}$
Munnopsoides eximius	12^{1}, 71^{2}	12^{1}, 71^{2}
Pseudamunnopsis beddardi	104^{2}, 105^{2}, 107^{1}, 108^{1}	104^{2}, 105^{2}, 107^{1}, 108^{1}
8	$3^{2>3}$, $6^{4>2}$, 19^{1}, 55^{1}, 96^{2}	$3^{2>3}$, $6^{4>2}$, 19^{1}, 55^{1}, 112^{2}
9	24^{2}, 25^{2}, 27^{2}, $\mathbf{49^{2}}$, 91^{2}, 93^{2}	24^{2}, 25^{2}, 27^{2}, $\mathbf{49^{2}}$, 91^{2}, 93^{2}

10 – Acanthocopinae / *Acanthocope*	17^{1}, 34^{2}, $35^{1>3}$, 47^{2}, 57^{1}, 77^{2}, 97^{2}, $\mathbf{99^{2}}$, $104^{1>3}$, $\mathbf{106^{2}}$, 108^{1}, 111^{2}, $114^{1>3}$, 116^{2}	17^{1}, 34^{2}, $35^{1>3}$, 47^{2}, 57^{1}, 77^{2}, 97^{2}, $\mathbf{99^{2}}$, $104^{1>3}$, $\mathbf{106^{2}}$, 111^{2}, 112^{1}, $114^{1>3}$, 116^{2}
Acanthocope unicornis	71^{2}, $110^{2>3}$	71^{2}, $110^{2>3}$
11 - Storthyngurinae	$\mathbf{4^{3>2}}$, 37^{2}, $48^{3>2}$, $59^{1>3}$, 60^{2}, $94^{1>3}$, 109^{1}, 112^{2}	$\mathbf{4^{3>2}}$, 37^{2}, $48^{3>2}$, $59^{1>3}$, 60^{2}, $94^{1>3}$, 108^{2}, 109^{1}
Storthyngura kussakini	66^{2}, 115^{1}	66^{2}, 115^{1}
12	45^{2}, $92^{1>3}$, $110^{2>3}$, 114^{2}	45^{2}, $92^{1>3}$, $110^{2>3}$, 114^{2}
13	27^{1}, 73^{2}, 74^{2}, 100^{2}	27^{1}, 73^{2}, 74^{2}, 95^{2}, 100^{2}
Storthyngura phyllosoma	17^{1}, 25^{1}, 91^{1}, 95^{2}, 96^{1}	17^{1}, 25^{1}, 91^{1}, 96^{1}
14	28^{2}, $\mathbf{46^{2}}$, $94^{3>1}$, 109^{2}, 121^{2}	$\mathbf{46^{2}}$, $94^{3>1}$, 109^{2}, 121^{2}
E		28^{2}, 42^{2}, 95^{1}
Storthyngurella menziesi	27^{2}, 42^{2}, 115^{1}	27^{2}, 115^{1}
Storthyngurella triplispinosa	28^{1}, 95^{2}	
15	34^{2}, 66^{2}, 109^{1}, 114^{1}	34^{2}, 66^{2}, 109^{1}, 114^{1}
Storthyngurella hirsuta	60^{1}, 73^{1}, 74^{1}	42^{1}, 60^{1}, 73^{1}, 74^{1}
16 - *Microprotus*	19^{2}, 37^{1}, 38^{2}, 41^{1}, 42^{2}, 47^{2}, 63^{2}, 81^{2}, 94^{2}, 100^{1}, 101^{1}, 108^{1}, 120^{2}	19^{2}, 37^{1}, 38^{2}, 41^{1}, 47^{2}, 63^{2}, 81^{2}, 94^{2}, 100^{1}, 101^{1}, 108^{1}, 120^{2}
Microprotus acutispinatus	28^{1}, 72^{2}	28^{1}, 72^{2}
17	78^{1}, 108^{1}	78^{1}, 108^{1}
18 - *Sursumura*	41^{1}, $94^{3>1}$, 97^{2}, 115^{1}	41^{1}, $94^{3>1}$, 97^{2}, 115^{1}
Sursumura aberrata	25^{1}, 42^{2}	25^{1}, 42^{2}
Sursumura spinosissima	114^{1}	114^{1}
19	75^{1}, 81^{2}, 109^{2}	75^{1}, 81^{2}, 109^{2}
Storthyngura elegans	79^{2}, $92^{3>1}$, $94^{3>2}$, 98^{1}	79^{2}, $92^{3>1}$, $94^{3>2}$, 98^{1}
20	76^{1}	76^{1}
Storthyngura parka	17^{1}, 83^{1}, $110^{3>2}$	17^{1}, 83^{1}, $110^{3>2}$
21	37^{1}, 45^{1}, 66^{2}, 70^{2}, 97^{2}, 115^{1}	37^{1}, 45^{1}, 66^{2}, 70^{2}, 115^{1}
22	42^{2}, 109^{1}	42^{2}, 109^{1}
Rectisura richardsonae	41^{1}	41^{1}
23 - *Vanhoeffenura*	17^{1}, $\mathbf{43^{2}}$, 83^{1}, 91^{1}, $94^{3>1}$, 113^{1}, 114^{1}, $118^{3>2}$	17^{1}, $\mathbf{43^{2}}$, 83^{1}, 91^{1}, $94^{3>1}$, 113^{1}, 114^{1}, $118^{3>2}$
Vanhoeffenura georgei	24^{1}, 25^{1}, 72^{2}, $92^{3>1}$, 97^{1}	24^{1}, 25^{1}, 72^{2}, $92^{3>1}$
F		70^{1}, 97^{2}
Vanhoeffenura bicornis	42^{1}	42^{1}
Vanhoeffenura moskalevi	70^{1} , 104^{2}	104^{2}
Vanhoeffenura myriamae	60^{1}, 81^{1}, 91^{2}, 115^{2}, 121^{2}	60^{1}, 81^{1}, 91^{2}, 115^{2}, 121^{2}
24	78^{1}, 83^{1}, 98^{1}, $101^{2>3}$, 121^{2}	75^{1}, 78^{1}, 81^{2}, 83^{1}, $118^{3>2}$, 121^{2}
25	$25^{4>1}$, $48^{3>1}$, 75^{1}, 76^{1}, 108^{1}, 112^{2}	

26	59^{2}, 81^{2}, 98^{2}, $101^{3>2}$, $110^{2>3}$, $118^{3>2}$	
G		$23^{4>1}$, 76^{1}, 109^{1}
Amuletta abyssorum	$48^{1>3}$, 56^{2}, 69^{2}, 72^{2}, 109^{1}, $119^{3>2}$	56^{2}, 69^{2}, 72^{2}, $110^{2>3}$, $119^{3>2}$
H		$48^{3>1}$, 98^{1}
27	17^{1}, 57^{1}, 59^{1}, 98^{1}	17^{1}, 57^{1}
28 - *Betamorpha*	27^{2}, $39^{2>3}$, 109^{1}, $110^{3>2}$, 112^{1}, $119^{3>1}$	27^{2}, $39^{2>3}$, 109^{1}, $119^{3>1}$
Betamorpha characta	108^{2}	108^{2}
29	6^{1}, 50^{2}, 52^{2}, 81^{1}	6^{1}, 50^{2}, 52^{2}, 81^{1}, 109^{2}, $110^{2>3}$
30 - *Munnopsurus*	41^{1}, 70^{2}, 111^{2}	41^{1}, 70^{2}, 111^{2}
Munnopsurus giganteus	51^{2}, 53^{2}, 85^{2}, 86^{2}, 88^{2}	51^{2}, 53^{2}, 85^{2}, 86^{2}, 88^{2}
Munnopsurus laevis	17^{2}	17^{2}
31 - Ilyarachninae	$\mathbf{4^{3>1}}$, $6^{1>3}$, 7^{2}, 39^{1}, 55^{2}, 71^{2}, $72^{1>3}$, $87^{1>3}$, 117^{2}, $119^{3>2}$	$\mathbf{4^{3>1}}$, $6^{1>3}$, 7^{2}, 55^{2}, 56^{2}, 71^{2}, $72^{1>3}$, $87^{1>3}$, 117^{2}, $119^{3>2}$
I		39^{1}
Echinozone coronata	56^{2}, $101^{2>3}$, 109^{1}, 114^{2}	$101^{2>3}$, 109^{1}, 114^{2}
J		56^{1}, $110^{3>2}$
Aspidarachna clypeata	13^{2}, 27^{2}, 51^{2}, 53^{2}, $110^{3>2}$	13^{2}, 27^{2}, 51^{2}, 53^{2}
32 - *Ilyarachna*	107^{2}, 108^{2}, $110^{3>2}$, 122^{1}	107^{2}, 108^{2}, 122^{1}
33	33^{2}, 39^{2}, 45^{2}, 56^{2}, 75^{2}, 76^{2}	33^{2}, 75^{2}, 76^{2}
K		45^{2}
34 - *Bathybadistes*	24^{2}, 25^{2}, 27^{2}, 47^{2}, 56^{1}, $\mathbf{90^{2}}$, $92^{1>3}$, 93^{2}, $101^{2>3}$, 122^{1}	24^{2}, 25^{2}, 27^{2}, 47^{2}, 56^{1}, $\mathbf{90^{2}}$, $92^{1>3}$, 93^{2}, $101^{2>3}$, 122^{1}
Bathybadistes andrewsi	17^{2}, 58^{2}	17^{2}, 58^{2}
35	17^{2}, 45^{1}, 51^{2}, 83^{2}, 116^{2}	17^{2}, 51^{2}, 83^{2}, 116^{2}
Pseudarachna hirsuta	39^{1}, 53^{2}, $110^{3>2}$, 111^{2}	39^{1}, 53^{2}, $110^{3>2}$, 111^{2}
36 – *Echinozone*	24^{2}, 28^{2}, 44^{2}, 69^{2}, 71^{1}, 92^{2}	24^{2}, 28^{2}, 44^{2}, 69^{2}, 71^{1}, 92^{2}
Echinozone longipes	19^{2}, 26^{2}	19^{2}, 26^{2}
Echinozone venusta	51^{1}, 108^{2}, 109^{1}	51^{1}, 108^{2}, 109^{1}
37 – *Notopais* (from clade K in analysis 4)	$\mathbf{5^{1}}$, $\mathbf{46^{1>3}}$, 109^{1}	$\mathbf{5^{1}}$, $\mathbf{46^{1>3}}$, 109^{1}
Notopais echinatus	51^{2}, 53^{2}, 75^{1}, 76^{1}	51^{2}, 53^{2}, 75^{1}, 76^{1}
38	$110^{3>2}$	$110^{3>2}$
Notopais spicata	47^{2}, 83^{2}, 95^{2}	47^{2}, 83^{2}, 95^{2}
Notopais spinosa	69^{2}, 71^{1}	69^{2}, 71^{1}
39	$3^{3>1}$, 6^{1}, $23^{1>3}$, 27^{2}, 39^{1}, 77^{2}, 84^{1}, $110^{3>2}$, $111^{1>4}$, 114^{2} 118^{1}, 121^{1}	$6^{4>1}$, 27^{2}, 39^{1}, 84^{1}, 118^{1}
L		$6^{2>4}$, 114^{2}, 121^{1}

M		59^{2}, 77^{2}, 85^{2}, 98^{2}, 109^{2}, $111^{1>3}$
N - Eurycopinae		$3^{3>1}$, 17^{1}, 85^{1}, 108^{2}
40 - *Baeonectes*	17^{1}, $23^{3>4}$, 67^{2}, 79^{2}, 108^{2} $111^{4>3}$	$23^{1>4}$, 67^{2}, 79^{2}
Baeonectes muticus	63^{2}	63^{2}
O		2^{1}, 13^{2}, $35^{1>3}$, 98^{1}, $111^{3>4}$
P		6^{2}, $23^{1>3}$, 38^{2}, 39^{2}
Q		17^{2}, $\mathbf{21^{2}}$, 87^{2}, 108^{1}
Belonectes parvus	13^{2}, 19^{2}, $\mathbf{21^{2}}$, 26^{2}, $35^{1>3}$, 38^{2}, 39^{2}, 87^{2}, 98^{1}, 102^{2}, 104^{2}, $110^{2>3}$, 113^{1}	2^{2}, 6^{1}, 19^{2}, 26^{2}, 102^{2}, 104^{2}, $110^{2>3}$, 113^{1}
Tytthocope megalura	2^{1}, 6^{2}, $\mathbf{21^{1>3}}$, 27^{1}, 32^{2}, 38^{2}, 81^{1}, 87^{2}, 95^{2}, 96^{1}, $111^{4>2}$, 115^{1}	13^{1}, $\mathbf{21^{2>3}}$, 27^{1}, 32^{2}, $35^{3>1}$, 39^{1}, 81^{1}, 95^{2}, 96^{1}, $111^{4>2}$, 115^{1}
41 - *Disconectes*	2^{1}, 6^{2}, $\mathbf{10^{2}}$, 13^{2}, 17^{1}, $35^{1>3}$, 38^{2}, 39^{2}, 108^{2}, 112^{1}	$\mathbf{10^{2}}$, 112^{1}
Disconectes furcatus	26^{2}	26^{2} , 98^{2}
Disconectes phalangium	27^{1}, 84^{2}, 98^{1}	27^{1}, 84^{2}
42 - *Eurycope*	2^{1}, 13^{2}, 17^{1}, $23^{3>1}$, 41^{1}, $66^{1>3}$, 98^{1}, 108^{2}, $110^{2>3}$	41^{1}, $66^{1>3}$, $110^{2>3}$
Eurycope cornuta	27^{1}, 84^{2}, 120^{2}	27^{1}, $35^{3>1}$, 84^{2}, 120^{2}
Eurycope sandersi	$35^{1>3}$, 60^{2}, 65^{1}, 81^{1}, 102^{2}, 121^{2}	60^{2}, 65^{1}, 81^{1}, 102^{2}, 121^{2}
43 - Lipomerinae	$3^{1>3}$, $23^{3>1}$, 26^{2}, 31^{2}, $48^{1>3}$, 82^{2}, 85^{2}, $87^{1>3}$, 102^{2}, $111^{4>2}$, 112^{1}, 121^{2}	26^{2}, 31^{2}, $48^{1>3}$, $82^{1>3}$, $87^{1>3}$, 112^{1}, 121^{2}
Coperonus pulcher	13^{2}, $82^{2>3}$, 102^{1}, $111^{2>3}$	13^{2}
Coperonus comptus (analysis 3 only)	17^{1}, 41^{1}	
R		67^{2}, 102^{2}, $111^{3>2}$
44 - *Mimcopelates*	42^{2}, 65^{1}, 67^{2}, $82^{2>3}$, $87^{3>4}$ 95^{2}, 121^{1}, 122^{1}	42^{2}, 65^{1}, $87^{3>4}$ 95^{2}, 121^{1}, 122^{1}
Mimcopelates anchibraziliensis	17^{1}, $110^{2>3}$, 115^{1}, 116^{2}	17^{1}, $110^{2>3}$, 115^{1}, 116^{2}
Mimcopelates longipes	13^{2}, 19^{2}, 76^{2}, 98^{1}	13^{2}, 19^{2}, 76^{2}, 98^{1}
S		$82^{3>2}$
Coperonus comptus (analysis 4 only)		17^{1}, 41^{1}, 67^{1}
45	$3^{3>4}$, 23^{2}, 27^{1}, 67^{2}, 71^{2}, 77^{1}, 81^{1}, 85^{1}, 117^{2}, $119^{3>2}$	$3^{3>4}$, 23^{2}, 27^{1}, 71^{2}, 77^{1}, 81^{1}, $119^{3>2}$
Lionectes humicephalotus	19^{2}, 42^{2}, 85^{2}, 117^{1}	19^{2}, 42^{2}
T		82^{1}, 85^{1}, 116^{2}, 117^{2}
Hapsidohedra ochlera	17^{1}, 52^{2}, 82^{1}, 84^{2}, 98^{1}, 102^{1}, 116^{2}	17^{1}, 52^{2}, 84^{2}, 98^{1}, 102^{1}

46 - *Lipomera*	27^{2}, 59^{1}, 71^{1}, $87^{3>4}$, $116^{1>3}$	27^{2}, 59^{1}, 71^{1}, $87^{3>4}$, $116^{2>3}$
Lipomera (Paralipomera) knorrae	39^{2}, 65^{1}, 82^{1}, 108^{2}, 115^{1}	39^{2}, 65^{1}, 108^{2}, 115^{1}
Lipomera (Tetracope) curvintestinata		82^{2}
U		19^{2}, 44^{2}, 63^{2}, $101^{2>3}$, 104^{2}, $114^{1>3}$
47 - Bathyopsurinae	13^{2}, 19^{2}, $\mathbf{20^{2}}$, $23^{1>4}$, 54^{2}, 56^{2}, 63^{2}, 70^{2}, 80^{2}, 87^{2}, $\mathbf{89^{2}}$, 100^{2}, 104^{2}	13^{2}, $\mathbf{20^{2}}$, $48^{3>1}$, 54^{2}, 56^{2}, 70^{2}, 80^{2}, 87^{2}, $\mathbf{89^{2}}$, 100^{2}
Bathyopsurus nybelini	41^{1}, 65^{1}, 67^{2}, 96^{1}	41^{1}, 44^{1}, 65^{1}, 67^{2}, 96^{1}, $101^{3>2}$
48 - *Paropsurus*	12^{2}, 44^{2}, 95^{2}, $101^{2>3}$	12^{2}, 95^{2}
Paropsurus giganteus	104^{1}, 108^{2}, $110^{3>2}$	104^{1}, 108^{2}
Paropsurus pellucidus	81^{1}, 105^{2}	81^{1}, 105^{2}, $110^{2>3}$
49 – *Munneurycope* (from clade M in analysis 4)	$6^{2>4}$, 19^{2}, 60^{2}, 70^{2}, 77^{2}, 85^{2}, 86^{2}, 88^{2}, 96^{1}, 104^{2}, $111^{1>4}$, 114^{2}, 115^{1}, 121^{1}, 122^{1}	19^{2}, 60^{2}, 70^{2}, 86^{2}, 88^{2}, 96^{1}, 104^{2}, $110^{2>3}$, $111^{3>4}$, 115^{1}, 122^{1}
Munneurycope incisa	108^{2}	108^{2}
Munneurycope murrayi	44^{2}, 100^{2}, $101^{2>3}$	44^{2}, 100^{2}, $101^{2>3}$
50 (from clade L in analysis 4)	$6^{2>4}$, 24^{2}, 69^{2}, 95^{2}, 105^{2}, 109^{1}, 121^{1}	24^{2}, 69^{2}, 81^{1}, 95^{2}, $101^{2>3}$, 105^{2}, $118^{2>3}$
Eurycope magna	2^{1}, $3^{3>1}$, 17^{1}	2^{1}, $3^{3>1}$, 17^{1}
Munnicope calyptra	19^{2}, 42^{2}	19^{2}, 42^{2}
51 - Syneurycopinae	19^{2}, 33^{2}, $\mathbf{36^{3>2}}$, $39^{2>3}$, 44^{2}, $\mathbf{61^{2}}$, $\mathbf{62^{2}}$, 63^{2}, $114^{1>3}$, 117^{2}, $119^{3>2}$	17^{1}, $\mathbf{36^{3>2}}$, $39^{2>3}$, $\mathbf{61^{2}}$, $\mathbf{62^{2}}$, 71^{2}, 98^{1}, 108^{2}, 112^{1}, 117^{2}
Bellibos (Bellibos) buzwilsoni (analysis 4 only)		26^{2}, 27^{2}, 37^{2}, 67^{2}, 72^{2}, 120^{2}
V		33^{2}, 75^{2}, 81^{1}, $119^{3>2}$
Bellibos (Bemerria) monicae (analysis 4 only)		71^{1}, 121^{1}
W		57^{1}
Bellibos (Bellibos) dageti (analysis 4 only)		19^{1}, 26^{2}, 27^{2}, 75^{1}, 120^{2}
52 – *Syneurycope*	$\mathbf{9^{2}}$, 57^{1}, 72^{2}, 83^{2}, $101^{3>1}$, 107^{2}	$\mathbf{9^{2}}$, 17^{2}, 72^{2}, 83^{2}, $101^{3>1}$, 104^{1}, 107^{2}
Syneurycope heezeni	58^{2}	58^{2}, 71^{1}
Syneurycope parallela	71^{2}	
53 – *Bellibos*	17^{1}, 104^{2}	

Bellibos (Bemerria) monicae (analysis 3 only)	121[1]	
54 - *Bellibos (Bellibos)*	26[2], 27[2], 71[2], 75[1], 120[2]	
Bellibos (Bellibos) buzwilsoni (analysis 3 only)	33[1], 37[2], 67[2], 72[2], 81[2], 119[2>3]	
Bellibos (Bellibos) dageti (analysis 3 only)	19[1], 57[1]	

Table 2.5 Revised classification of the munnopsid-clade.

Family	**Included genera**
Acanthocopidae Wolff, 1962	*Acanthocope* Beddard, 1885
	Microprotus Richardson, 1910a
	Storthyngura Vanhöffen, 1914
	Storthyngurella Malyutina, 1999b
	Sursumura Malyutina, 1999a
	Platyprotus Just, 2001
	Rectisura Malyutina, 2003a
	Vanhoeffenura Malyutina, 2004
Lipomeridae Tattersall 1905a	*Amuletta* Wilson and Thistle, 1985
	Aspidarachna Sars, 1897
	Baeonectes Wilson, 1982
	Bathybadistes Hessler and Thistle, 1975
	Bathyopsurus Nordenstam, 1955
	Belonectes Wilson and Hessler, 1981
	Betamorpha Hessler and Thistle, 1975
	Coperonus Wilson, 1989
	Disconectes Wilson and Hessler, 1981
	Echinozone Sars, 1897
	Eurycope Sars, 1864
	Hapsidohedra Wilson, 1989
	Ilyarachna Sars, 1864
	Lionectes Wilson, 1989
	Lipomera Tattersall, 1905a
	Mimocopelates Wilson, 1989
	Munneurycope Stephensen, 1913
	Munnicope Menzies and George, 1972
	Munnopsurus Richardson, 1912b
	Notopais Hodgson, 1910
	Paropsurus Wolff, 1962
	Pseudarachna Sars, 1897
	Tytthocope Wilson and Hessler, 1981
Munnopsidae Lilljeborg, 1864	*Acanthomunnopsis* Schultz, 1978
	Munnopsis Sars, 1861
	Munnopsoides Tattersall, 1905a
	Paramunnopsis Hansen, 1916
	Pseudomunnopsis Hansen, 1916
Syneurycopidae Wolff, 1962	*Bellibos* Haugsness and Hessler, 1979
	Syneurycope Hansen, 1916

Table 3.1 Character matrix as analysed in PAUP for the *Ilyarachna*-group.

1234567890 1234567890 1234567890 1234567890 1234567890 1234567890 1
Betamorpha acuticoxalis 12-23---23 21211311-1 34-11311-2 2-11112111 ??11121111 1221---2-1 1
Betamorpha characta 12-23---23 21211311-1 34-11311-2 2-11112111 ??11121111 122?---2-1 1
Munnopsurus giganteus 32-23---23 21211311-1 34-21211-2 1-21212112 ??11121111 1111---2-3 1
Munnopsurus laevis 32-23---23 21211311-2 34-21211-2 1-11112112 ??11121111 11??---2-3 1
Aspidarachna carinata 21?2313-23 21111311-1 ??-1131112 1?22212111 ?112221111 1211???1?2 ?
Aspidarachna clypeata 2122323-23 21131311-1 34-1131112 1122212111 2112221111 1111221132 1
Aspidarachna glabra 21?23??-23 21211311-1 ??-1131112 1222211121 211222111? 1112222132 3
Bathybadistes andrewsi 2141311113 2121131221 1411131121 1112111221 2112212211 1111121132 2
Bathybadistes fragilis 2141311113 2121131221 1411131121 1112111221 2112212211 1111121132 2
Bathybadistes spinosissima 2141311113 2123131231 1411131121 1?12111?1 ??12212211 11??121132 2
Echinozone coronata 2132311113 21212311-1 3421131112 111212---1 2112221111 1122211132 1
Echinozone longipes 21???11123 2223132211 ??11121212 1?2212---1 1112211111 1111211122 3
Echinozone scabra 21???11113 2223212211 ??11121212 1?1212---1 111221111? 1?21211112 3
Echinozone trispinosa 21?1311113 22231322-1 ??21121112 1?1212---1 1112211112 12?1211112 3

Echinozone tuberculata 21?1311123 2223212211 ??11121211 1?2212---1 111221111? 1?11211132 3
Echinozone venusta 21?1311113 2223232211 ??11121211 1?1212---1 1112211111 1221211112 3
Epikopais mystax 2152311222 21231211-1 34-1121?12 122212---1 311222112? ??12211132 1
Epikopais pilosus 2152311122 21211311-2 32-1121112 122222---1 3112221111 1122221132 1
Epikopais waringa 2152311222 21231211-1 34-1121112 122212---1 3112221121 2-12221132 1
Ilyarachna aculeatus 2141311121 21111111-2 2411131112 1112112111 2112221111 2-21221132 2
Ilyarachna antarctica 2142111121 21211311-1 24-1131112 1112111221 2112221112 ???1221132 3
Ilyarachna bergandahli 2142111121 21211311-1 34-1131112 1112112111 3112221111 11?1221132 3
Ilyarachna bicornis 2141311121 21211311-1 2411131?12 1112112221 211222111? ???1221132 3
Ilyarachna cheropin 2142311123 21211311-2 34-1131112 1112112111 2112221112 1111221132 2
Ilyarachna crozetensis 2142111121 21211211-1 ?4-1131112 1112112221 2112221112 2-21221132 3
Ilyarachna crystallum 2142111121 21211311-1 14-1131112 1112112??1 ??1222111? ??21221132 3
Ilyarachna dubia 2142111121 21211311-1 34-1131112 1112112111 ??12221111 1111221132 3
Ilyarachna flindersi 2142311121 21211311-1 24-1131112 1112112221 3112221112 2-11211132 2
Ilyarachna frami 2142111121 21211211-1 34-1131112 1?12112111 2112221111 1211221132 3

Ilyarachna franki 2141311121 21211311-1 2411131112 1112112221 1112221111 2 1111221132 2
Ilyarachna hirticeps 2142111121 21211311-1 34-1131112 1112112111 2112221111 1211221132 2
Ilyarachna kermadecensis 2141311121 21211311-1 2411131212 1112112211 1112221112 2-21221132 3
Ilyarachna kurilensis 2141311113 21211311-1 ??21131112 1?1211???1 1212221111 2-21221112 3
Ilyarachna kussakini 2142111121 21211311-1 ??21131112 1112111221 111222111? 2-21221112 3
Ilyarachna longicornis 2142311123 21211311-1 34-1131112 1112112121 2112221111 2 1211221132 2
Ilyarachna mediorientalis 2142311123 21211311-2 ??-1131112 1112112121 ??12221111 12?1221132 3
Ilyarachna moana 2142111121 21211311-1 2411131112 1112112121 1112221112 1111221132 2
Ilyarachna mokari 2142311121 21211311-1 24-1131112 1112112221 2112221112 2-112?1132 ?
Ilyarachna nordenstami 2142111121 21211311-1 34-1131212 1112112221 2112221112 2-?1221132 2
Ilyarachna pacifica 2141311113 21212311-1 1411131112 1112112221 ??12221111 1111211132 2
Ilyarachna perarmata 2141311113 21212311-1 ???1131112 1112112221 2112211112 1121221132 3
Ilyarachna plana 2142111123 21211311-1 34-1131112 1112112111 ??12221111 2-?1221132 2
Ilyarachna polita 2142111121 21211311-2 34-1131112 1112111221 ??12221111 3 2-112?11?2 2
Ilyarachna profunda 2142111121 21211211-2 34-1131112 1112111221 2112221111 2-?1211132 3

Ilyarachna propinqua 2142311123 21211211-1 ??-1131112 1112112221 ??1222111? ??21221112 3
Ilyarachna quorna 2141311121 21211311-1 2411131112 1112112211 1112221112 2-112?1132 ?
Ilyarachna taranui 2141311113 21212311-2 3211131112 1112112111 ??12221112 2-?1211132 2
Ilyarachna taratara 2141311113 21211311-1 3111131112 1112112221 1112221111 1211211132 2
Ilyarachna torleivi 2142111121 21211311-1 34-1131112 1112112111 2112221111 11?1221132 2
Ilyarachna una 2142311121 21211311-1 31-1131112 1112112221 ??12221111 4 2-?1221132 2
Ilyarachna zachsi 2141311113 21211311-1 ??21131132 1112112221 1112221112 1121221112 3
Notopais chathamensis 2141311113 21212311-1 1411121132 112222---1 2112221111 1221221132 1
Notopais echinatus 2141311113 21212311-1 3111121132 112222---1 2112211111 1121222132 1
Notopais euaxos 2141311113 21212311-1 3111121132 112222---1 211221111? 1?21222132 1
Notopais likros 2141311113 21211211-1 3111131132 112222---1 2112221111 1121221132 1
Notopais minya 2141311113 21211311-1 3111131132 112222---1 2112221111 1121221132 1
Notopais quadrispinosa 2141311113 21212311-2 ??11121131 111212---1 2112221111 1121221132 1
Notopais spicata 2141311113 21212311-2 1411121131 111212---1 2112221111 1121122132 1
Notopais spinosa 2141311113 21212311-1 3311121132 111212---1 1112221111 1121221132 1

Notopais zealandica 2142311121 21211111-1 31-1121132 112222---1 211222111? 1?22222132 1
Nyctobadistes hamatus 2141311113 2123131211 1421112111 1112111221 2112211111 1111???1?2 ?
Pseudarachna hirsuta 2112212-13 11231311-1 3412212112 112222---1 222222111? ??11221132 3
Pseudarachna nohinohi 2112212-13 11231311-1 3412212112 112222---1 222222111? ??11222132 3

Table 3.2 Weights after successive weighting and consistency indices for the characters used in the analysis of the *Ilyarachna*-group.

character number	weight after reweighting	CI of weighted characters
1	1.00	1.0
2	1.00	1.0
3	1.00	1.0
4	0.22	0.25
5	0.62	0.667
6	1.00	1.0
7	1.00	1.0
8	1.00	1.0
9	0.17	0.2
10	0.64	0.667
11	1.00	1.0
12	1.00	1.0
13	0.25	0.5
14	0.13	0.2
15	0.05	0.111
16	0.02	0.2
17	1.00	1.0
18	1.00	1.0
19	1.00	1.0
20	0.03	0.125
21	0.19	0.286
22	0.40	0.6
23	0.00	0.167
24	0.33	0.5
25	1.00	1.0
26	0.21	0.286
27	0.25	0.5
28	0.10	0.25
29	1.00	1.0
30	0.14	0.25
31	1.00	1.0
32	1.00	1.0
33	0.20	0.25
34	1.00	1.0
35	0.19	0.25
36	0.16	0.2
37	0.16	0.25
38	0.30	0.333
39	0.15	0.2
40	1.00	1.0
41	0.09	0.182
42	0.25	0.5
43	1.00	1.0

44	1.00	1.0
45	1.00	1.0
46	0.45	0.5
47	1.00	1.0
48	1.00	1.0
49	1.00	1.0
50	0.03	0.1
51	0.11	0.167
52	0.04	0.125
53	0.09	0.125
54	0.20	0.333
55	0.33	0.5
56	0.09	0.167
57	0.04	0.2
58	1.00	1.0
59	0.20	0.333
60	1.00	1.0
61	0.12	0.154

Table 3.3. Character states defining clades or terminal taxa in the strict consensus tree for the successively weighted analysis (Fig. 3.4). Those characters with a superscript 1 refer to a transformation from state 2 to 1 and those with a superscript 2 refer to a transformation from state 1 to 2. Characters in **bold** have a CI=1.

Clade or terminal taxon	**Defining characters – successively reweighted analysis**
1 - *Betamorpha*	**31**$^{\mathbf{2}}$, 52^{2}, 53^{2}
2 - *Munnopsurus*	**1**$^{\mathbf{1>3}}$, 24^{2}, 26$^{3>2}$, **40**$^{\mathbf{2}}$, **60**$^{\mathbf{1>3}}$
Munnopsurus giganteus	33^{2}, 35^{2}
Munnopsurus laevis	20^{2}
3	**1**$^{\mathbf{2}}$, **2**$^{\mathbf{1}}$, **34**$^{\mathbf{2}}$, **44**$^{\mathbf{2}}$, **45**$^{\mathbf{2}}$, **58**$^{\mathbf{1}}$, **60**$^{\mathbf{2}}$, 61^{2}
4	**3**$^{\mathbf{4>1}}$, 33^{2}, 35^{2}, 61^{1}
5 - *Aspidarachna*	**3**$^{\mathbf{2}}$, **7**$^{\mathbf{1>3}}$, 13^{1}
Aspidarachna carinata	52^{2}
Aspidarachna clypeata	**6**$^{\mathbf{2}}$, 14^{2}
6	**3**$^{\mathbf{1>5}}$, **32**$^{\mathbf{2}}$, 37^{1}, 39^{2}, 54^{2}
Aspidarachna glabra	57^{2}, 61$^{1>3}$
7	10$^{3>2}$, 26$^{3>2}$, 36^{2}, 41$^{2>3}$
Epikopais pilosus	20^{2}, 22$^{4>2}$, 53^{2}
8	**8**$^{\mathbf{2}}$, 14^{2}, 16$^{3>2}$, 35^{1}, **49**$^{\mathbf{2}}$, 51^{2}
Epikopais mystax	56^{1}
9 - *Pseudarachna*	5$^{3>2}$, **7**$^{\mathbf{2}}$, 9^{1}, **11**$^{\mathbf{1}}$, 14^{2}, 24^{2}, **25**$^{\mathbf{2}}$, 26$^{3>1}$, 27^{2}, 36^{2}, 42^{2}, **43**$^{\mathbf{2}}$, 61$^{1>3}$
Pseudarachna nohinohi	57^{2}
10	9^{1}, 15^{2}, 56^{1}
Echinozone coronata	**3**$^{\mathbf{4>3}}$, 23^{2}, 36^{2}, 53^{2}, 54^{2}, 61^{1}
11	4^{1}, 41^{1}
Ilyarachna taranui	20^{2}, 22$^{4>2}$, 50^{2}, 51^{2}
12	15^{1}, 38^{2}, 39^{2}
Ilyarachna taratara	22$^{4>1}$, 52^{2}
13	21$^{3>1}$
Ilyarachna pacifica	15^{2}
14	53^{2}, 56^{2}, 59$^{3>1}$, 61$^{2>3}$
Ilyarachna kurilensis	23^{2}, 42^{2}, 51^{2}
Ilyarachna propinqua	4^{2}, 9^{2}, 16$^{3>2}$
15	15^{2}, 41^{2}, 46^{1}, 59$^{1>3}$
Ilyarachna perarmata	50^{2}
16	14^{2}, **18**$^{\mathbf{2}}$, 37^{1}, 53^{1}
17	15^{1}, 30^{1}, 55^{1}, 61$^{3>2}$
Nyctobadistes hamatus	23^{2}, 26$^{3>1}$, 27^{2}
18 - *Bathybadistes*	**19**$^{\mathbf{2}}$, **29**$^{\mathbf{2}}$, **47**$^{\mathbf{2}}$, **48**$^{\mathbf{2}}$
Bathybadistes spinosissima	**19**$^{\mathbf{2>3}}$
19	14^{1}
20	**12**$^{\mathbf{2}}$, **17**$^{\mathbf{2}}$, 26$^{3>2}$, 28^{2}, 36^{2}, 41^{1}, 56^{1}
21	52^{2}, 53^{2}, 59$^{3>1}$

Echinozone trispinosa	15^{1}, 23^{2}, 28^{1}, 50^{2}
Echinozone scabra	$16^{3>1}$
Echinozone venusta	30^{1}
22	9^{2}, 33^{2}
Echinozone longipes	15^{1}, $59^{3>2}$
Echinozone tuberculata	$16^{3>1}$, 30^{1}
23	$\mathbf{29^{1>3}}$
Ilyarachna zachsi	23^{2}, 50^{2}
24 - *Notopais*	15^{2}, $26^{3>2}$, 36^{2}, $59^{1>3}$, $61^{3>1}$
Notopais spinosa	$21^{1>3}$, $22^{4>3}$
25	41^{2}
26	20^{2}, 30^{1}
Notopais spicata	55^{1}, 57^{2}
27	33^{2}, 35^{2}
Notopais chathamensis	52^{2}
28	$21^{1>3}$, $22^{4>1}$, 57^{2}
29	46^{1}
30	15^{1}
Notopais zealandica	4^{2}, 9^{2}, $10^{3>1}$, $16^{3>1}$, 54^{2}
31	$26^{2>3}$, 57^{1}
Notopais likros	$16^{3>2}$
32	$5^{3>1}$
Ilyarachna plana	51^{2}
33	$10^{3>1}$
Ilyarachna hirticeps	52^{2}
34	$61^{2>3}$
Ilyarachna bergandahli	$41^{2>3}$
Ilyarachna frami	$16^{3>2}$, 52^{2}
35	39^{2}, 50^{2}
Ilyarachna moana	$21^{3>2}$, 41^{1}
36	38^{2}, 51^{2}
Ilyarachna nordenstami	28^{2}
37	23^{2}, 53^{2}, $61^{2>3}$
Ilyarachna crozetensis	$16^{3>2}$
38	37^{1}
Ilyarachna antarctica	$21^{3>2}$
Ilyarachna kussakini	41^{1}, $59^{3>1}$
Ilyarachna profunda	$16^{3>2}$, 20^{2}, 50^{1}, 56^{1}
39	$5^{1>3}$
40	50^{1}
Ilyarachna polita	20^{2}, 37^{1}
41	$22^{3>2}$
Ilyarachna flindersi	$41^{2>3}$, 56^{1}
42	4^{1}
Ilyarachna bicornis	$61^{2>3}$
43	41^{1}

Ilyarachna franki	50[1], 51[1]
44	39[1]
45	53[2]
Ilyarachna aculeatus	13[1], 16[3>1], 20[2], 38[1], 41[2], 50[1]
Ilyarachna kermadecensis	28[2], 61[2>3]
46	20[2]
Ilyarachna cheropin	50[2]
47	39[2], 52[2]
Ilyarachna mediorientalis	61[2>3]

Table 4.1 Revised generic placement of the species of the *Ilyarachna*-group.

Genus	**Species**	**Genus transferred from (if applicable)**
Aspidarachna Sars, 1897b	*clypeata* (Sars, 1870)	
	carinata (Birstein, 1963)	
	sekhari (George and Menzies, 1968)	
Bathybadistes Hessler & Thistle 1975	*andrewsi* n. sp.	
	fragilis Merrin *et. al.*, submitted	
	gurjanovae (Menzies, 1962)	
	hoplitis Hessler & Thistle, 1975	
	multispinosa (Menzies, 1962)	
	spinosissima Hansen 1916	
Echinozone Sars, 1897b	*coronata* (Sars, 1870)	
Epikopais n. gen.	*aries* (Vanhöffen, 1914)	*Echinozone*
	mystax n. sp.	
	pilosus n. sp.	
	waringa n. sp.	
Ilyarachna Sars, 1870	*acarina* Menzies and Barnard, 1959	
	aculeatus n. sp.	
	affinis Barnard, 1920	
	antarctica Vanhöffen, 1914	
	armata Thistle, 1980	
	australis n. sp.	
	bergendali Ohlin, 1901	
	bicornis Hansen, 1916	
	calidus George and Menzies, 1968	
	calva Pasternak, 1982	
	cheropin n. sp.	
	crassiceps Barnard ,1920	
	crozetensis Kensley, 1980	
	crystallum n. sp.	

	distincta Birstein, 1971	
	dubia Hansen, 1916	
	flindersi n. sp.	
	frami Just, 1980	
	franki n. sp.	
	hirticeps Sars, 1870	
	longicornis (Sars, 1864)	
	kermadecensis Wolff, 1962	
	kurilensis Kussakin and Mezhov, 1979	
	kussakini Birstein, 1963	
	medorientalis Chardy, 1974	
	moana n. sp.	
	mokari n. sp.	
	nordenstami Wolff, 1962	
	quorna n. sp.	
	pacifica n. sp.	
	perarmata Birstein, 1971	
	pervica Menzies and George, 1972	
	plana Thistle, 1980	
	polita Bonnier, 1896	
	profunda Schultz, 1966	
	propinqua Birstein, 1971	
	setosa Kussakin, 1979	
	taranui n. sp.	
	taratara n. sp.	
	triangulata Menzies, 1962	
	torleivi Svavarsson, 1988	
	una Thistle, 1980	
	vemae Menzies and George, 1972	
	wolffi Kensley, 1978	
	zachsi Gurjanova, 1933	
Notopais Hodgson, 1910	*beddardi* Merrin, 2004	
	chathamensis n. sp.	
	echinatus n. sp.	
	euaxos n. sp.	
	magnifica (Vanhöffen, 1914)	
	likros n. sp.	
	minya Merrin, 2004	

	quadrispinosa (Beddard, 1886)	
	spicata Hodgson, 1910	
	spinosa (Hodgson, 1902)	
	zealandica Merrin, 2004	
Nyctobadistes n. gen.	*hamatus* n. sp.	
Pseudarachna Sars, 1897	*hirsuta* (Sars, 1864)	
	nohinohi n. sp.	

Incertae sedis
Aspidarachna glabra (Birstein, 1971)
Echinozone arctica Hansen, 1916
Echinozone bispinosa Kussakin and Vasina, 1982
Echinozone longipes (Birstein, 1963)*
Echinozone scarbra (Birstein, 1971)*
Echinozone trispinosa Kussakin and Vasina, 1993*
Echinozone tuberculata (Birstein, 1971)*
Echinozone venusta (Birstein, 1971)*

* species in ‘Group A’ (see Chapter 3 for details)

Appendix 2.1 Species used in the phylogenetic analysis of the Munnopsidae. Abbreviations used: BMNH – Natural History Museum, London; NIWA – National Institute of Water and Atmospheric Research, Wellington; NMV – Museum Victoria, Melbourne; ZMUO – Zoological Museum, University of Oslo. * represents type species.

Outgroup family	**Genus**	**Species**	**References used and notes**
Desmosomatidae Sars, 1897	*Desmosoma* Sars, 1864	*hesslera* Brandt, 1992b	Brandt 1992b; species name incorrectly constructed, species will be referred to as *Desmosoma hessleri*
	Eugerda Meinert, 1890	*gigantea* Park, 1999	Park 1999
Ingroup Munnopsidae Sub-family	**Genus**	**Species**	**References used**
Acanthocopinae Wolff, 1962	*Acanthocope* Beddard, 1885	*beddardi* Malyutina, 1999a	Malyutina 1999
		unicornis Menzies, 1962	Menzies 1962; Malyutina 1999
Bathyopsurinae Wolff, 1962	*Bathyopsurus* Nordenstam, 1955	**nybelini* Nordenstam, 1955	Nordenstam 1955; Wolff 1962
	Paropsurus Wolff, 1962	**giganteus* Wolff, 1962	Wolff 1962
		pellucidus (Beddard, 1885)	Beddard 1886; Wolff 1962
Betamorphinae Kussakin, 2003	*Amuletta* Wilson and Thistle, 1985	**abyssorum* (Richardson, 1911)	Wilson and Thistle 1985
	Betamorpha Hessler and Thistle, 1975	*acuticoxalis* (Birstein, 1963)	Birstein 1963; Thistle and Hessler 1977
		**characta* Hessler and Thistle, 1975	Hessler and Thistle 1975; Thistle and Hessler 1977

Eurycopinae Hansen, 1916	*Baeonectes* Wilson, 1982	*improvisus* Wilson, 1982	Wilson 1982b; also see Wilson 1989 for pleopod details for this genus
		**muticus* (Sars, 1864)	Sars 1899; also see Wilson 1989 for pleopod details for this genus
	Belonectes Wilson and Hessler, 1981	**parvus* (Bonnier, 1896)	Wilson and Hessler 1981
	Disconectes Wilson and Hessler, 1981	*furcatus* (Sars, 1870)	Sars 1899
		**phalangium* (Sars, 1864)	Sars 1899; Wilson and Hessler 1981
	Eurycope Sars, 1864	**cornuta* Sars, 1864	Sars 1899; Wilson and Hessler 1980
		magna Birstein, 1963	Birstein 1963; Kussakin 2003
		sandersi Wilson, 1982a	Wilson 1982a
	Tytthocope Wilson and Hessler, 1981	**megalura* (Sars, 1872)	Sars 1899; Wilson and Hessler 1981
Ilyarachninae Hansen, 1916	*Aspidarachna* Sars, 1897	**clypeata* (Sars, 1870)	Sars 1897; also studied: type material ZMUO F10025 and ZMUO F10034, additional material ZMUO F15356 and ZMUO F15494
	Bathybadistes Hessler and Thistle, 1975	*andrewsi* n. sp.	This thesis
		fragilis Merrin *et al*., submitted	Merrin *et al*. submitted

	Echinozone Sars, 1897	**coronata* (Sars, 1870)	Sars 1897; also studied: type material ZMUO F10032, ZMUO F10033, ZMUO F15357, additional material ZMUO F15492
		longipes (Birstein, 1963)	Birstein 1963
		venusta (Birstein, 1971)	Birstein 1971
	Ilyarachna Sars, 1864	*hirticeps* Sars, 1870	Sars 1897; also studied: type material ZMUO F15352, ZMUO F10022, ZMUO F10023, ZMUO F10028, ZMUO F10029, ZMUO F10030, ZMUO F15352, additional material ZMUO F15489
		**longicornis* (Sars, 1864)	Sars 1897; also studied: type material ZMUO F19145, ZMUO F10031, additional material ZMUO F15353, ZMUO F15354, ZMUO F15479
	Notopais Hodgson, 1910	*echinatus* n. sp.	This thesis

		**spicata* Hodgson, 1910	Schultz 1976; Merrin 2004b; this thesis; also studied: holotype BMNH 1910.3.18.150, additional male ZMHB 17739, NIWA material
		spinosa Hodgson, 1902	Schultz 1976; this thesis; also studied: syntype BMNH 1901.12.13.7, NIWA material
	Pseudarachna Sars, 1897	**hirsuta* (Sars, 1864)	Sars 1897; also studied: type material ZMUO F10026, ZMUO F10027, ZMUO F19146, additional material ZMUO F15493, ZMUO F19146
Lipomerinae Tattersall 1905a	*Coperonus* Wilson, 1989	**comptus* Wilson, 1989	Wilson 1989
		pulcher Brandt, 1992a	Brandt 1992a
	Hapsidohedra Wislon, 1989	**ochlera* Wilson, 1989	Wilson 1989
	Lionectes Wilson, 1989	**humicephalotus* Wilson, 1989	Wilson 1989
	Lipomera Tattersall, 1905a (*Paralipomerinae*) Wilson, 1989	*knorrae* Wilson, 1989	Wilson 1989
	(*Tetracope*) Wilson, 1989	*curvintestinata* Wilson, 1989	Wilson 1989
	Mimocopelates Wilson, 1989	**longipes* Wilson, 1989	Wilson 1989

		anchibraziliensis Wilson, 1989	Wilson 1989
Munnopsinae Lilljeborg, 1864	*Acathomunnopsis* Schultz, 1978	**hystrix* Schultz, 1978	Shultz 1978; Wilson 1982b
		milleri Wilson, 1982b	Wilson 1982b
	Munnopsis Sars, 1861	*bathyalis* Wolff, 1962	Wolff 1962
		longiremis Richardson 1912a	Wolff 1962
		**typica* Sars, 1861	Sars 1899
	Munnopsoides Tattersall, 1905a	*eximius* Hansen, 1916	Hansen 1916; Wolff 1962
	Paramunnopsis Hansen, 1916	*justi* Svavarsson, 1988	Svavarsson 1988a; Malyutina and Kussakin 1996; (also see Wilson 1989 for more details for this genus)
		**oceanica* (Tattersall, 1905b)	Tattersall 1905b; Hansen 1916; Kussakin 2003
	Pseudomunnopsis Hansen, 1916	**beddardi* (Tattersall, 1905a)	Tattersall 1905b; Hansen 1916
Storthyngurinae Kussakin, 2003	*Microprotus* Richardson 1910a	*acutispinatus* Wilson *et al*., 1989	Wilson *et al*. 1989
		**caecus* Richardson, 1910a	Wilson *et al.* 1989
	Storthyngurella Malyutina, 1999b	**hirsuta* Malyutina, 1999b	Malyutina 1999b
		menziesi Malyutina, 1999b	Malyutina 1999b
		triplispinosa (Menzies, 1962)	Menzies 1962; Malyutina 1999b
	Storthyngura Vanhöffen, 1914	**elegans* Vanhöffen, 1914	Malyutina and Wägele 2001

		kussakini Brandt and Malyutina, 2002	Brandt and Malyutina 2002; Malyutina and Brandt 2004
		parka Malyutina and Wägele, 2001	Malyutina and Wägele 2001
		phyllosoma (Just, 2001)	Just 2001; Malyutina and Brandt 2004
	Sursumura Malyutina, 2003a	*aberrata* Malyutina, 2003a	Malyutina 2003b
		spinosissima (Brandt, 2002)	Brandt 2002
	Rectisura Malyutina, 2003a	*richardsonae* Malyutina, 2003a	Malyutina 2003b
		serrata (Wolff, 1962)	Wolff 1962
	Vanhoeffenura Malyutina, 2004	*bicornis* (Birstein, 1957)	Malyutina 2003b; Kussakin 2003
		georgei (Malyutina, 2003a)	Malyutina 2003b
		moskalevi (Malyutina, 2003a)	Malyutina 2003b
		myriamae (George and Hinton, 1982)	George and Hinton 1982; Malyutina 2003b
Syneurycopinae Wolff, 1962	*Bellibos* Haugsness and Hessler, 1979 (*Bellibos*) Haugsness and Hessler, 1979	**buzwilsoni* Haugsness and Hessler, 1979	Haugsness and Hessler 1979; (also see Wilson 1989 for pleopod details for this genus)
		dageti (Chardy, 1975)	Chardy 1975; Haugsness and Hessler 1979 (also see Wilson 1989 for pleopod details for this genus)

	(*Bemerria*) Haugsness and Hessler, 1979	*monicae* (Chardy, 1975)	Chardy 1975; Haugsness and Hessler 1979; also see Wilson 1989 for pleopod details for this genus
	Syneurycope Hansen, 1916	*heezeni* Menzies, 1962	Menzies 1962; Haugsness and Hessler 1979
		**parallela* Hansen, 1916	Hansen 1916; Haugsness and Hessler 1979
Incertae sedis	*Munneurycope* Stephensen, 1913	*incisa* Gurjanova, 1946	Svavarsson 1987; Kussakin 2003
		**murrayi* (Walker, 1903)	Stephensen 1915; Hansen 1916; Wolff 1962
	Munnicope Menzies and George, 1972	**calyptra* Menzies and George, 1972	Menzies and George 1972; sketches also used from G. D. F. Wilson (pers. comm.)
	Munnopsurus Richardson, 1912b	**giganteus* (Sars, 1879)	Brandt 1997; Kussakin 2003
		laevis (Richardson, 1910b)	Kussakin 2003

Appendix 2.2 Characters used in phylogenetic analysis of the Munnopsidae with the states as used in the data matrix entered in brackets.

Body and Cephalon

1. *Body*: without natasome (1); with natasome (2).
2. *Cephalon vertex with anterior projection (visible in lateral view)*: present (1; Fig. 2.2A; see arrow); absent (2; e.g. Fig. 2.2B).
3. *Frontal arch*: absent (1; Fig. 2.2A); incipient (2; Fig. 2.2B); present (3; Figs 2.2C and D); frons flat, arch reduced (4; Fig. 2.2E).
4. *Frontal arch*: broad, flat (1; Fig. 2.3D); narrow inverted v (2; Fig. 2.3F); curved around clypeus (3; Figs 2.3C and E).
5. *If frontal arch broad and flat*: frons narrow, frontal arch meeting maxillipeds at a wide angle, making them almost horizontal in lateral view (1); frons not as narrow, frontal arch meeting maxillipeds at a more acute angle, laterally appear more triangular than horizontal (2).
6. *Clypeus*: with high arch (1; Figs 2.2A, C and E); with low, wide arch (2); with small arch just in centre (3; Fig. 2.2D); not arched at all (4; Fig. 2.2B).
7. *Cephalon*: not trapezoid and wider posteriorly (1); trapezoid, wider posteriorly (2).
8. *Cephalon with spines*: absent (1); present (2).
9. *Between cephalon and pereonite 1*: suture present (1); no suture present, segments completely fused (2).
10. *Pereonites 1–4 ventrally*: do not bulge lower than anterior part of pereonites 5–7 (1); bulge lower than anterior part of pereonites 5–7 (2; Fig. 2.2G).
11. *Pereonites 1–4*: width sub-equal or narrower to that of pereonites 5–7 (1); much wider than pereonites 5–7 (2; Fig 2.2H).
12. *Pereonites 1–4 length*: sub-equal (1); not sub-equal, pereonite 1 reduced considerably (2; Figs 2.2H and I).
13. *Length of pereonites 5–7 is*: less than twice length of pereonites 1–4 (1); more than twice length of pereonites 1–4 (2).
14. *Pereonite 1 anterior margin with*: no spines (1); 1 spine (2); many spines (3).
15. *Pereonite 2 anterior margin with*: no spines (1); 1 spine (2); many spines (3).

16. *Pereonite 3 anterior margin with*: no spines (1); 1 spine (2); many spines (3).
17. *Pereonite 3 anterolateral corners*: indented, forming a lobe or spine-like extension (1); not indented (2; Fig. 2.2J).
18. *Pereonite 4 anterior margin* with: no spines (1); 1 spine (2); many spines (3).
19. *Pereonite 4 anterolateral corners*: indented, forming a lobe or spine-like extension (1; Fig. 2.2J); not indented (2).
20. *Natasome*: not larger and considerably more swollen than anterior half (1); larger and considerably more swollen than anterior half (2; Fig. 2.2I).
21. *Natasome*: ventrally with no enlarged or recessed areas (1); pereonite 5 ventrally enlarged (2); pereonite 6 ventrally enlarged (3; Fig. 2.2K).
22. *Dorsal sutures between pereonites*: 5–7 present (1); 5 and 6 absent, 6 and 7 present (2); 5 and 6 present, 6 and 7 absent (3); 5–7 absent (4).
23. *Natasomal pereonites, dorsally*: distinct and unfused (1); 5–6 distinct and unfused, 6–7 fused (2); 5–6 fused, 6–7 distinct and unfused (3); immovably fused (even if sutures are present) (4).
24. *Pereonites 5–7*: lateral margins not as narrow, pereonites 'fit' into each other, natasome not so reduced (1; Figs 2.2I and 2.3B); lateral margins narrowing, pereonite margins distinct from each other (2; Figs 2.2J and 2.3A).
25. *Pereonites 5–7 with narrow lateral extensions*: absent (1); present (2; Fig. 2.2J).
26. *Pereonite 5*: size sub-equal or smaller than pereonite 6 (1); size much larger than pereonite 6 (2; Fig. 2.3B).
27. *Pereonite 5*: not wider than rest of body (1); wider than rest of body (2).
28. *Pereonite 5*: wide anteriorly, not narrowing into elongated neck (1); anteriorly narrowing into elongated neck (2; Fig. 2.3A).
29. *Pereonite 5 dorsally with*: no spines (1); 1 spine (2); 2 spines (3); 3 or more spines (4).
30. *Pereonite 6 dorsally with*: no spines (1); 1 spine (2); 2 spines (3); 3 or more spines (4).
31. *Pereonite 7*: present (1); reduced or absent (2; Fig. 2.3B).
32. *Pereonite 7 dorsally with*: no spines (1); 1 spine (2); 2 spines (3); 3 or more spines (4).

33. *Spines or tubercles*: without apical seta (1); with apical seta (2).
34. *Dorsal suture between pleon and rest of body*: present (1); absent (2).

Antennae

35. *Antenna 1 inserted*: not directly behind antenna 2, more towards the centre (1); not directly behind antenna 2, more towards the outside (2); directly behind antenna 2 (3).
36. *Antenna 1 article 1*: tubular (1); sub-cylindrical (2; Fig. 2.3C); broadened with a flattened lateral flange, and thickened medially (3).
37. *Antenna 1 article 1*: without spine-like projection (1); with spine-like projection (2; Figs 2.3E and F).
38. *Antenna article 1 lateral margin*: not serrate (1); serrate (2 Fig. 2.3D).
39. *Antenna 1 article 1*: bilobed (1; Figs 2.3D and G); with 1 lobe (2; Figs 2.3F and H); with no lobe (3; Fig. 2.3C).
40. *Antenna 1 article 2 inserted*: dorsally on article 1 (1); laterally on article 1 (2; Fig. 2.3I).
41. *Antenna 1 article 2*: shorter than longest lobe on article 1 (1); longer than longest lobe on article 1 (2).
42. *Antenna 1 article 2 distal lobe*: absent (1); present (2; Fig. 2.3F).
43. *Antenna 1 article 2*: without proximal process (1); with proximal process (2; Fig. 2.3J).
44. Antenna 1 article 3: the same or shorter than article 1 (1); longer than article 1 (2).
45. *Antenna 2 article 1*: without spine (1); with spine (2).
46. *Antenna 2 article 1*: with short spine (1; Fig. 2.3E); with elongate spine (2; Fig. 2.4A); with prominent 'horn-like' spine (3; Fig. 2.4B).
47. *Antenna 2 article 2*: without spines (1); with spines (2).
48. *Antenna 2 antennal scale*: present, not fused (1; Fig. 2.3D); present, but somewhat fused (2; Fig. 2.3E); absent (3).
49. *Antenna 2 article 3*: without spines (1); with spines (2).

Mouthparts

50. *Mandible, incisor process*: not enlarged and rounded, cusps well differentiated (1); enlarged and rounded, cusps either slightly defined or completely absent (2; Fig. 2.4C).
51. *Mandible, lacinia mobilis*: present (1); absent (2).
52. *Lacinia mobilis, if present*: not reduced (1); reduced (2).
53. *Mandible, spine row*: present (1); absent (2).
54. *Mandibular molar*: present (1); reduced or absent (2).
55. *Mandibular molar (if present)*: broad and truncate (1; Fig. 2.4E); triangular, not broad and truncate (2; Fig. 2.4C).
56. *Mandibular palp*: present (1); absent (2).
57. *Mandibular palp*: slender and feeble (1; Fig. 2.4H); thick and robust (2; Fig. 2.4E).
58. *Mandibular palp*: reaching beyond end of mandible (1); not reaching beyond end of mandible (2).
59. *Mandibular palp article 3*: elongate and narrow (1; Figs 2.4D and H); curls in on itself (somewhat) laterally (2; Fig. 2.4G); wide, flap-like, folds over dorso-ventrally (3; Fig. 2.4E); laminar, hooks over (4; Fig. 2.4F).
60. *Mandible palp article 3*: with at least 1 long prominent terminal seta (1; Figs 2.4D, G and H); with no long prominent terminal setae (2; Figs 2.4E and F).
61. *Maxilliped with coupling hooks*: present (1; Fig. 2.4I); absent (2; Fig. 2.4J).
62. *Maxilliped palp article 3*: without denticles (1; Fig. 2.4I); with denticles (2; Fig. 2.4J).
63. *Maxilliped palp article 4*: with distal projection on mesial margin (1; Fig. 2.4I); with no projection present on mesial margin (2; Fig. 2.4J).
64. *Maxilliped palp articles 4 and 5*: article 4 is bigger than 5 (1); article 4 and 5 are of similar size (2).
65. *Maxilliped epipod*: reaching at or below article 1 of palp (1); reaching beyond article 1 of palp (2).

66. *Maxilliped epipod*: without lateral projection or process (1; Fig. 2.4J); with small projection, square or notch-like (2; Fig. 2.4I); with large lateral quadrate projection (3; Fig. 2.5A; see arrows on respective Figures).
67. *Maxilliped epipod*: elongate, distally narrowing (1; Figs 2.4I, J and 2.5A); sub-oval, distally broad, not narrowing to a tip (2; Fig. 2.5B).

Pereopods

68. *Dactylar claws of pereopods*: simple, not enclosing sensillae (1); troughlike, enclosing sensillae (2).
69. *Pereopod 1*: slender (1; Fig. 2.5C); robust (2; Fig. 2.5D).
70. *Pereopod 1 basis length*: sub-equal or less than basis of pereopod 2 (1); much longer than basis of pereopod 2 (2).
71. *Pereopod 1, carpus, inferior margin with*: setae evenly spread (1; Fig. 2.5D); setae more predominant in proximal half (2; Fig. 2.5C).
72. *Ambulatory pereopod*: bases 2–4 approximately same length (1); bases 3–4 shorter than basis 2 (2); bases 3–4 length near width and much shorter than basis 2 (3).
73. *Pereopods 5–7*: carpus and propodus somewhat flattened and expanded (even if slightly) (1); propodus and carpus tubular, not flattened or expanded (2).
74. *Pereopods 5–7*: with natatory setae (1); without natatory setae (2).
75. *If natatory, pereopod 5 carpus superior margin, proximal region*: margin projecting over merus (1; Fig. 2.5E); margin not projecting over merus (2; Fig. 2.5F).
76. *If natatory, pereopod 6 carpus superior margin, proximal region*: margin projecting over merus (1); margin not projecting over merus (2).
77. *Pereopods 5–7 bases*: sub-equal or longer than pereopod 4 basis (1); shorter than pereopod 4 basis (2).
78. *If natatory, pereopods 5–7 ischium superior margin*: with natatory setae (1); without natatory setae (2).

79. *Pereopods 5–7 propodus inferior margin with natatory setae*: relatively evenly spread along margin (1); coming down half way of margin (2; Fig. 2.5F); just distally (3).
80. *Pereopod 5 inserted*: at same height as pereopods 6 and 7 (1); higher than pereopods 6 and 7 (2).
81. *Pereopod 5 basis*: sub-equal or longer than basis of pereopod 6 (1); shorter than basis of pereopod 6 (2).
82. *Pereopod 5 merus*: short (1); elongate, but shorter than basis (2); elongate, longer than basis (3).
83. *Pereopod 5 carpus is somewhat expanded, its length is*: less than twice width (1);more than twice width (2).
84. *If pereopod 5 propodus is somewhat expanded*: length less than twice width (1); length more than twice width (2).
85. *Pereopod 5 dactylus*: long (1); rudimentary (2); absent (3).
86. *Pereopod 6 dactylus*: long (1); rudimentary (2); absent (3).
87. *Pereopod 7*: near size of pereopod 6 (1); smaller than pereopod 6 but functionally natatory (2); smaller than pereopod 6 with narrow carpi and propodi (3); rudimentary or absent (4).
88. *Pereopod 7 dactylus*: long (1); rudimentary (2); absent (3).

Pleonites and Pleotelson

89. *Pleonite 1, if free*: width less than that of anterior margin of pleotelson (1; Fig. 2.2J); width equal to that of anterior margin of pleon (2; Fig. 2.2I).
90. *Pleotelson anterolateral corners with spine and apical seta*: absent (1; Figs 2.2H and I); present (2; Fig. 2.2J).
91. *Pleotelson (not including anterolateral spine if present)*: without lateral extensions (1); with lateral extensions (2; Figs 2.5G and H).
92. *Pleotelson dorsally with*: no ornamentation (1); tubercles (2); spines (3).
93. *Distal pleotelson margin*: without projection (1); with projection (2).
94. *Pleotelson distal projection*: spine-like (1; Fig. 2.5G); with notch (2; Fig. 2.5H); square (3; Fig. 2.5I).

95. *Pleotelson (excluding distal projection if present)*: length less than or equal to pereonites 5–7 combined (1); length longer than pereonites 5–7 combined (2).

Pleopods

96. *Female operculum keel*: absent (1); present (2).
97. *Female operculum spine*: absent (1); present (2; Fig. 2.5J).
98. *Operculum keel*: with setae (1): without setae (2).
99. *Male pleopod 1*: elongate, length sub-equal or longer than pleopod 2, *in situ* sits over entire medial junction of pleopods 2 (1); short, length is less than half of pleopod 2, *in situ* sits at proximal end of medial junction of pleopods 2 (2).
100. *Male pleopod 1*: distal lobes medially joined for nearly entire length of pleopod, distally not widely parted (1); distal lobes making acute angle to each other, distally are widely parted (2; Fig. 2.6A).
101. *Male pleopod 1 outer ramus*: longer than inner ramus (1); rami length sub-equal (2); shorter than inner ramus (3).
102. *Male pleopod 2*: widest medially (1); widest proximally (2).
103. *Male pleopod 2*: pleopods are not fused together (1); pleopods are somewhat fused together (2; Fig. 2.6B).
104. *Male pleopod 2 exopod situated*: on mesial margin, not next to or on distal margin (1); on mesial margin, next to or on distal margin (2); on proximal margin of protopod (3).
105. *Male pleopod 2 stylet and exopod*: not reduced (1); reduced and small (2; Fig. 2.6B).
106. *Male pleopod 2 stylet situated*: on mesial margin on protopod (1); on proximal margin of protopod (2).
107. *Male pleopod 2 stylet*: not filiform (1); filiform (2).
108. *Male pleopod 2 stylet article 2*: less than half of protopod length (1); half or more than protopod length (2).
109. *Pleopod 3 endopod distal tip with*: more than 3 plumose setae (1); 3 or less plumose setae (2).

110. *Pleopod 3 exopod*: reduced and small (1); elongate, can be sub-equal with, but not extending past endopod (2); extending past endopod (3).
111. *Pleopod 3 exopod distal tip with*: more than 3 plumose setae (1); 2 or 3 plumose setae (2); 1 plumose seta (3); no plumose setae (4).
112. *Pleopod 3 exopod of*: one article (1); two articles (2).
113. *Pleopod 3 exopod*: article 1 wider than article 2, abrupt change in width between articles (1; Fig. 2.5C); no abrupt change between width of articles, either exopod gradually narrows distally or widths of articles are sub-equal (2).
114. *Pleopod 4 exopod with*: many (more than 1) plumose setae (1); 1 plumose seta (2); no plumose setae (3).
115. *Pleopod 4 exopod*: more than or equal to half endopod width (1); less than half endopod width (2).

Uropods

116. *Uropods*: biramous (1); uniramous (2); lacking rami (3).
117. *Uropodal protopod*: somewhat tubular, oval to sub-oval in cross section (1; Figs 2.4I and J); flattened, leaf-like (2; Fig. 2.5D).
118. *Uropod protopod, if tubular*: reduced, often wider than long, unable to be seen beyond telson in dorsal view (1); small, can usually just be seen beyond telson in dorsal view (2); elongate, prominent beyond telson in dorsal view (3).
119. *Uropodal ramus inserted*: proximally on protopod (1); distolaterally on protopod (2); distally on protopod (3).
120. *Uropodal rami*: not equal in length (1); sub-equal in length (2).
121. *Uropodal endopod*: longer than protopod (1); shorter than protopod (2).
122. *Uropod exopod*: tiny or rudimentary (1; Fig. 2.5D; see arrow); large, articulating article (2).

Appendix 3.1 The species composition of the *Ilyarachna-group* genera prior to the analysis. Abbreviations used: BIOICE – Benthic Invertebrates in Icelandic Waters; BMNH – Natural History Museum, London; NIWA – National Institute of Water and Atmospheric Research, Wellington; NMV – Museum Victoria, Melbourne; USNM – National Museum of Natural History, Smithsonian Institution, Washington DC; ZMHB – Museum für Naturkunde der Humboldt-Universität, Berlin; ZMUC – Zoological Museum, University of Copenhagen; ZMUO – Zoological Museum, University of Oslo; * indicates type species.

Genus	**species**	**type locality**	**included in analysis**	**References used and material examined for analysis**
Aspidarachna Sars, 1897b	**clypeata* (Sars, 1870)	Lofoten Islands	Y	Sars, 1897; type material ZMUO F10025 and ZMUO F10034, additional material ZMUO F15356 and ZMUO F15494
	carinata (Birstein, 1963)	N.W. Pacific Ocean	Y	Birstein 1963
	glabra (Birstein, 1971)	N.W. Pacific Ocean	Y	Birstein, 1971
	sekhari (George and Menzies, 1968b)	Mediterranean Sea	N	
Bathybadistes Hessler and Thistle 1975	*andrewsi* n. sp.	S.E. Atlantic	Y	This thesis
	fragilis Merrin *et. al.*, submitted	Weddell Sea, Antarctica	Y	Merrin *et al*. submitted
	gurjanovae (Menzies, 1962)	S.E. Atlantic	N	
	**hoplitis* Hessler & Thistle, 1975	eastern Atlantic Ocean	N	
	multispinosa (Menzies, 1962)	S.W. Atlantic	N	

	spinosissima Hansen, 1916	Davis Strait	Y	Hansen 1916; Merrin *et al*. submitted
Echinozone Sars, 1897b	*arctica* Hansen, 1916	Norway	N	
	aries (Vanhöffen, 1914)	Antarctica	N	
	bispinosa Kussakin and Vasina, 1982	Kerguelen Island	N	
	**coronata* (Sars, 1870)	Lofoten Islands	Y	Sars 1897; type material ZMUO F10032, ZMUO F10033, ZMUO F15357, additional material ZMUO F15492
	longipes (Birstein, 1963)	N.W. Pacific	Y	Birstein 1963
	scarbra (Birstein, 1971)	N.W. Pacific	Y	Birstein 1971
	trispinosa Kussakin and Vasina, 1993	N.W. Pacific	Y	Kussakin 2003
	tuberculata (Birstein, 1971)	N.W. Pacific	Y	Birstein 1971
	venusta (Birstein, 1971)	N.W. Pacific	Y	Birstein 1971
Epikopais *n. gen.*	*mystax* n. sp.	New Zealand	Y	This thesis
	**pilosus* n. sp.	S.E. Australia	Y	This thesis
	waringa n. sp.	S.E. Australia	Y	This thesis
Ilyarachna Sars, 1870	*acarina* Menzies and Barnard, 1959	California	N	

	aculeatus n. sp.	New Zealand	Y	This thesis
	affinis Barnard, 1920	South Africa	N	
	antarctica Vanhöffen, 1914	Antarctica	Y	Vanhöffen, 1914; Wolff, 1962; Thistle, 1980; type material ZMHB17737
	armata Thistle, 1980	S.W. Atlantic	N	
	australis n. sp.	New Zealand	N	
	bergendali Ohlin, 1901	Greenland	Y	Svavarsson 1988; material BIOICE 2111
	bicornis Hansen, 1916	Davis Strait	Y	Wolff, 1962; Thistle, 1980
	calidus George and Menzies, 1968b	Mediterranean Sea	N	
	calva Pasternak, 1982	Mediterranean Sea	N	
	cheropin n. sp.		Y	This thesis
	crassiceps Barnard, 1920	South Africa	N	
	crozetensis Kensley, 1980	Crozet Island	Y	Kensley 1980; paratype USNM 173120
	crystallum n. sp.	S.E. Australia	Y	This thesis
	distincta Birstein, 1971	N.W. Pacific	N	
	dubia Hansen, 1916	N.E. of Iceland	Y	Hansen 1916; Wolff 1962; Just 1980; Thistle 1980
	flindersi n. sp.	S.E. Australia	Y	This thesis
	frami Just, 1980	Arctic	Y	Just, 1980
	franki n. sp.	New Zealand	Y	This thesis

	hirticeps Sars, 1870	Lofoten Islands	Y	Sars 1897; Thistle 1980; type material ZMUO F15352, ZMUO F10022, ZMUO F10023, ZMUO F10028, ZMUO F10029, ZMUO F10030, ZMUO F15352, additional material ZMUO F15489
	**longicornis* (Sars, 1864)	Chritiana Fjord	Y	Sars 1897; type material ZMUO F19145, ZMUO F10031, additional material ZMUO F15353, ZMUO F15354, ZMUO F15479
	kermadecensis Wolff, 1962	Kermadec Trench	Y	Wolff 1956; Wolff 1962; type material ZMUC-CRU-6967
	kurilensis Kussakin and Mezhov, 1979	Kurile Islands	Y	Kussakin and Mezhov 1979
	kussakini Birstein, 1963	N.W. Pacific	Y	Birstein 1963
	medorientalis Chardy, 1974	Aegean Sea	Y	Chardy 1974
	moana n. sp.	New Zealand	Y	This thesis
	mokari n. sp.	S.E. Australia	Y	This thesis
	nordenstami Wolff, 1962	South Georgia	Y	Nordenstam 1933; Wolff 1962; Thistle 1980
	quorna n. sp.	S.E. Australia	Y	This thesis
	pacifica n. sp.	New Zealand	Y	This thesis
	perarmata Birstein, 1971	N.W. Pacific	Y	Birstein 1971
	pervica Menzies and George, 1972	Peru-Chile Trench	N	

	plana Thistle, 1980	Brazil	Y	Thistle 1980; type material USNM 170776, USNM 170777
	polita Bonnier, 1896	Bay of Biscay	Y	Wolff 1962; Thistle 1980
	profunda Schultz, 1966	La Jolla Conyon	Y	Schultz 1966; Thistle 1979
	propinqua Birstein, 1971	N.W. Pacific	Y	Birstein 1971
	setosa Kussakin, 1979	N.W. Pacific	N	
	taranui n. sp.	New Zealand	Y	This thesis
	taratara n. sp.	New Zealand	Y	This thesis
	triangulata Menzies, 1962	S.E. Atlantic	N	
	torleivi Svavarsson, 1988	Norwegian Sea	Y	Svavarsson 1988; material BIOICE 2088
	una Thistle, 1980	N.W. Atlantic	Y	Thistle 1980
	vemae Menzies and George, 1972	Peru-Chile Trench	N	
	wolffi Kensley, 1978	South Africa	N	
	zachsi Gurjanova, 1933	Sea of Japan	Y	Kussakin 2003; Golovan and Malyutina 2006
Notopais Hodgson, 1910	*beddardi* Merrin, 2004b	Kerguelen Island	N	
	chathamensis n. sp.	New Zealand	Y	This thesis
	echinatus n. sp.	S.E. Australia	Y	This thesis
	euaxos n. sp.	Tasman Sea	Y	This thesis
	likros n. sp.	S.E. Australia	Y	This thesis
	magnifica (Vanhöffen, 1914)	Davis Sea, Antarctica	N	
	minya Merrin, 2004b	S.E. Australia	Y	Merrin 2004b; this thesis; holotype NMV J52877, paratypes NMV J52876

	quadrispinosa (Beddard, 1886)	Kerguelen Island	Y	Nordemstam 1933; Merrin 2004b; this thesis; lectotype BMNH 1889.4.27.73
	spicata Hodgson, 1910	McMurdo Sound, Antarctica	Y	Merrin 2004b; Schultz 1976; this thesis; holotype BMNH 1910.3.18.150, additional male ZMHB 17739
	spinosa (Hodgson, 1902)	Cape Adare, Antarctica	Y	Schultz 1976; this thesis; syntype BMNH 1901.12.13.7
	zealandica Merrin, 2004b	New Zealand	Y	Merrin 2004b; this thesis; holotype NIWA 3303, paratypes NIWA 3304
Nyctobadistes n. gen.	*hamatus* n. sp.	S.E. Australia	Y	This thesis
Pseudarachna Sars, 1897	*hirsuta* (Sars, 1864)	Norway	Y	Sars 1897; type material ZMUO F10026, ZMUO F10027, ZMUO F19146, additional material ZMUO F15493, ZMUO F19146
	nohinohi n. sp.	New Zealand	Y	This thesis

Appendix 3.2 Characters used in phylogenetic analysis of the *Ilyarachna*-group with the states as used in the data matrix entered in brackets.

Body and Cephalon

1. *Clypeus*: with low wide arch (1; Fig. 2.2A); with small arch, just in centre (2; Fig. 2.2D); with high arch (3; Fig. 2.2E).
2. *Cephalon*: widening distally, trapezoid in shape (1); not widening distally or trapezoid in shape (2).
3. *Frons*: enlarged, semi-circular (1; Fig. 3.1B); narrow, with defined ridge around antennae, ridge almost meeting mandibles (2; Fig. 3.1A); elongate, trapezoid (3; Fig. 3.1C); short, slightly trapezoid (more rectangular), broad (4; Fig. 3.1D); short, laterally rounded (5; Fig. 3.1E; see arrows on Figures).
4. *Cephalon dorsally with*: spines (usually come in pairs) (1); no spines (2).
5. *Cephalon dorsally with*: robust/stout setae (usually scattered) (1); simple setae (2); no setae (3).
6. *Cephalon dorsally with*: sculpting, dorsal region of cephalon defined from more lateral areas (1; Figs 3.1F and 3.1G); no sculpting, cephalon surface even, with no defined areas (2; Fig. 3.1H).
7. *Anterior region of cephalon* with: dorsal flange structures (1; Fig. 3.1F); flanges absent, with no ridge (2; Fig. 3.1G); flanges absent, with even ridge (3; Fig. 3.1H).
8. *Flanges*: small, not large extensions (1); large, well developed extensions (2).
9. *Pereonites 1–4 anterior margins*: with dorsal spines (1); without dorsal spines (2).
10. *Pereonites 1–4 anterior margins with*: robust setae (1); simple setae (2); no setae (3).
11. *Pereonite 2*: larger than pereonite 3 (1; Fig. 3.1G); sub-equal in length to pereonite 3 (2).
12. *Pereonite 4*: not directed toward posterior margin, similar in shape to pereonite 3 (1; Fig. 2.2J); directed toward posterior margin (2; Fig. 3.1I).
13. *Pereonites 1–4*: short, compact (1); not short and compact (2).

14. *Dorso-centrally pereonite 5 length*: shorter than pereonite 6 (1); sub-equal or longer than pereonite 6 (2).
15. *Pereonite 5 anterior margin with*: no spines (1); spines (2).
16. *Pereonite 5 anterior margin with*: robust setae (1); simple setae (2); no setae (3).
17. *Pereonite 5*: lateral margins not elongate and forming a 'neck' (1; Fig. 2.2J); lateral margins narrowing anteriorly, elongate forming a 'neck' (2; Figs 2.3A and 3.1I).
18. *Pereonites 5–7*: lateral margins not so narrow, pereonites 'fit' into each other, natasome not as reduced (1; Fig. 3.1K); lateral margins narrowing, pereonite margins distinct from each other (2; Figs 2.2J and 2.3A).
19. *If narrowing and distinct from each other, pereonites 5–7 lateral margins*: rounded, can be almost square (1; Fig. 3.1K); narrow, elongate, akin to a single spine (2; Fig. 2.2J); jagged, with many spines (3; Fig. 3.1J).
20. *Pereonite 6*: dorsally not encroaching into at least half of pereonite 5 (1); dorsally encroaching into at least half of pereonite 5 (2).
21. *Pereonite 7 ventrally*: with more then 1 spine (1); with medial spine (2); without spines (3).
22. *Pereonite 7 ventrally with*: median ridge bearing many setae (1); pair of setae (2); bump bearing setae (3) no median ridge or bump bearing setae (4).
23. *Spines/tubercles on pereonites each*: with apical seta (1); without apical seta (2).

Antennae

24. *Antennae based*: towards the middle of the cephalon (1); not towards middle of cephalon, but out wide, with a large interantennal gap between (2).
25. *Antenna 1*: not reduced in size (1); reduced in size (2).
26. *Distally antenna 1 article 1*: with no distal points (1; Fig. 3.1L); rounded, sub-cylindrical with 1 distal point (2; Fig. 2.3H); with 2 distal points, distolateral point biggest, distomesial point smaller, can be almost horizontal (3; Fig. 3.2A).

27. *Antenna 1 article 1*: with no large lateral extension (1); with large lateral extension (2; Fig. 3.1L).
28. *Antenna 1 article 3 length*: less than article 1 (1); equal or more than article 1 (2).
29. *Antenna 2 article 1 distolateral angle*: spine absent (may have pronounced angle with robust seta, but not considered a spine) (1); with small spine and robust seta (2); with horn-like prominent spine and robust seta (3; Fig. 2.4B).
30. *Antenna 2 article 2*: with spine/s (1); without spine/s (2).

Mouthparts

31. *Mandible incisor process*: large, no differentiation of cusps (1; Fig. 2.4C); dentate (2).
32. *Mandibular fossa*: angular, running sub-horizontally across mandible (1; Fig. 3.2B); curved, running laterally along mandible (2; Fig. 3.2C; see arrows on Figures).
33. *Left mandible with lacinia mobilis*: present (1); absent (2).
34. *Mandibular molar*: broad and truncate (1); not broad and truncate; small, narrow, flap-like (2; Fig. 2.4C).
35. *Mandibular spine row*: present (1); absent (2).
36. *Mandibular palp*: present (1); absent (2).
37. *Mandibular palp article 2 length*: sub-equal or shorter than length of article 1 (1); longer than article 1 (2).
38. *Mandibular palp article 2*: with short pectinate setae (1; Fig. 3.2D); without short pectinate setae (2).
39. *Mandibular palp article 3 with*: row of short setae along margin (1; Fig. 3.2D; see arrow); no row of short setae along margin (2).

Pereopods

40. *Pereopod 1 basis length*: sub-equal or less than basis of pereopod 2 (1); much longer than basis of pereopod 2 (2).

41. *Pereopod 1 carpus, inferior margin with*: a dense row of setae (1; Fig. 2.5D); elongate setae that concentrates in proximal region (2; Fig. 2.5C); neither a dense setal row nor elongate setae concentrated in proximal region of carpus (3).
42. *Pereopod 1 propodus*: sub-equal or shorter than carpus (1); longer than carpus (2).
43. *Pereopod 2*: not enlarged, ischium not short or thick, much longer than merus (1); enlarged, robust, ischium short, thick, not much longer than merus (2).
44. *Basis of pereopods 2–4*: approximately the same length (1); pereopods 3 and 4 much shorter than pereopod 2 (2).
45. *Pereopod 7*: near size of pereopod 6 (1); smaller than pereopod 6 with narrow carpi and propodi (2).

Pleon and Pleonites

46. *Pleon*: with dorsal ornamentation (1); without dorsal ornamentation (2).
47. *Pleon anterolateral corners*: smooth, with no lateral spine (1; Fig. 2.3A); with spine and distal seta (2; Figs 2.2J and 3.1J; see arrow).
48. *Pleon distal margin*: with no projection (1); with projection (2; Fig. 2.2J).
49. *Operculum keel*: not wide or bulbous, keel coming to a narrow ridge (1); prominent, wide, bulbous (2; Fig. 3.2E).
50. *Male pleopod 1 lateral rami*: length sub-equal or shorter the mesial rami (1); extend noticeably beyond mesial rami, often are straight (2).
51. *Stylet of male pleopod 2*: does not hook up into proximal half (1; Fig. 3.2G); does hook up into proximal half (2; Fig. 3.2F).
52. *If does not hook up, male pleopod 2 stylet*: does not extend beyond distal margin of protopod distal (1); does extend beyond distal margin of protopod (2).
53. *Pleopod 3 endopod with*: 3 or less plumose setae (1); more than 3 plumose setae (2).
54. *Pleopod 4 exopod with*: more than 1 plumose seta (1); 1 plumose seta (2).

Uropods

55. *Uropod protopod*: triangular, wider proximally than distally (1; Fig. 2.6D); not triangular or wider proximally than distally (2).
56. *Uropod protopod*: length less than twice width (1); length more than or equal to twice width (2).
57. *Uropod protopod*: with no distal bulb (1); with distal bulb (2; Fig. 3.2H; see arrow).
58. *Uropod protopod*: flattened (1); tubular (2).
59. *Uropod protopod mesial margin with*: row of long plumose setae, similar to that seen on lateral margin (1); row of simple setae (2); few to no plumose setae, never many setae in a row like on lateral margin (3).
60. *Uropod rami located*: proximally on protopod (1); distolaterally of protopod (2); distally on protopod (3).
61. *Uropod exopod*: article large, articulating (1); tiny and/or rudimentary (2; Fig. 2.6D); absent (3)

Appendix: A

MARINE BIODIVERSITY

The unknown marine asellote isopod crustaceans of New Zealand

Kelly Merrin

New Zealand's waters, especially the deep sea, remain one of the world's reserves of yet-to-be discovered biodiversity.

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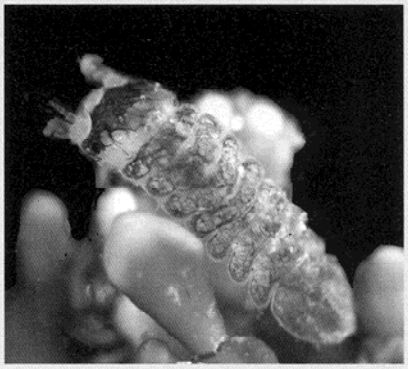
It has been said that more is known about outer space than the depths of our oceans. So it's not surprising that the huge diversity of deep-ocean habitats may not be appreciated as much as, for example, the Amazon rainforest. Recent research voyages have uncovered many fish and invertebrate species new to science. It is anyone's guess how many thousands of species are still waiting to be discovered. This article covers just one group of crustaceans – the asellote isopods. Initial studies suggest that there is remarkable diversity in this group in the deep seas around New Zealand.

Asellotes: deep-sea specialists

The suborder Asellota is a large group of aquatic **isopods**. The group has 29 known families and over 1800 species worldwide, in habitats ranging from freshwater to marine, and from tropical to polar waters.

Although asellotes are predominately deep-sea, 13 families have shallow-water representatives. Many species are common on rocky shores, living, for example, in coralline red algal turf (patches of low-growing red seaweed) in the intertidal zone. However, it is in the deep sea, particularly at depths over 500 metres, where these animals come into their own. Most of the isopods here are asellotes. Some individuals from the genus *Storthyngura* (family Munnopsididae) have even been found at the phenomenal depth of 8430 metres in the Kurile–Kamchatka Trench in the north-west Pacific. This is not only one of the deepest known habitats for isopods, but also for Crustacea as a whole. New Zealand's deepest trench, the Kermadec Trench, is home to 12 species of isopod, all asellotes, inhabiting depths between 4410 and 7000 metres.



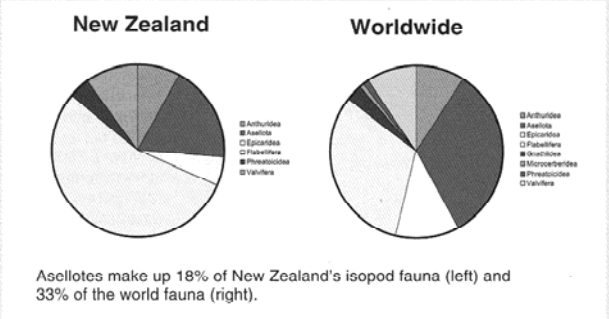
A new species of *Joeropsis* (Joeropsididae) taken from coralline turf algae collected from Island Bay, Wellington. (Photo: Kelly Merrin)

Asellotes are **detritivores** and, for many deep-sea representatives, this is all we know about their general biology.

Asellote isopods in New Zealand

What we know about asellote taxonomy is largely due to a few scientists who have worked on this group over the past 200 years. The earliest inroads into the description of the asellote fauna of New Zealand were made by Charles Chilton in 1884, when he published his description of *Iathrippa longicauda* from Cook Strait. About half of the known species have been described by just two people. Torben Wolff, from Denmark, studied specimens collected during the round-the-world voyage of the *Galathea* in 1950–52. British zoologist Roger Lincoln described the New Zealand Haploniscidae in 1985.

Several studies have indicated that the south-west corner of the Pacific Ocean is one of the richest locations on the planet for marine biodiversity. Studies of isopod diversity from the south-eastern Australian continental slope



Asellotes make up 18% of New Zealand's isopod fauna (left) and 33% of the world fauna (right).

Appendix: A

revealed 359 species from 36 families. Over two-thirds of these were asellotes and only 10% of the material could be identified to known species. There are no reasons to think that New Zealand's isopod fauna would not be as rich.

Globally, asellotes make up a third of all currently known aquatic isopods (see pie charts, lower left), but in New Zealand, the proportion is only 18% (45 species). It is probable that the proportions are the same everywhere, implying that many undiscovered asellote species live in New Zealand waters.

Some scientists believe there could be over 400,000 species of marine isopods worldwide, considering the high rates of change seen in areas such as the North Pacific. Applying the one-third proportion referred to above suggests that over 130,000 of these would be asellotes – that is a lot of new species in addition to the 1800 already known!

One example of the diversity potential of asellotes in New Zealand is in the sub-family Ilyarachninae (Munnopsididae). Currently there is just one known representative from New Zealand, *Ilyarachna kermadecensis* Wolff (1962) from the Kermadec Trench. Research on specimens from the shelves of NIWA's biological collections has revealed 13 species collected from the EEZ, and initial examination suggests that most of these are new to science. If this 13-fold increase in diversity applied to all 45 of New Zealand's known asellote species, that would mean potentially over 500 species awaiting discovery.

New Zealand's isopods show a high level of **endemism** and many families show **Gondwana** connections. A greater understanding of fauna such as asellote isopods will not only increase our knowledge of New Zealand's unique biodiversity but will also give us further insight into the biogeographical history of our area. ■

Further reading

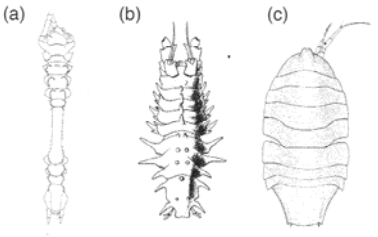
Batson, P. (2003). Deep New Zealand: blue water, black abyss. Canterbury University Press, Christchurch. 240 p.

Gage, J.D.; Tyler, P.A. (1991). Deep-sea biology: a natural history of organisms at the deep-sea floor. Cambridge University Press, Cambridge. 504 p.

Poore, G.C.B.; Just, J.; Cohen, B.F. (1994). Composition and diversity of Crustacea Isopoda of the southeastern Australian continental slope. *Deep-Sea Research 41*: 677–693.

From the mundane to the bizarre

Most asellote species are between 2 and 6 mm long, with just a few giant species reaching over a centimetre. There is a wide array of body plans, from the familiar flattened shape of their terrestrial isopod cousins, the slaters or wood-lice, to some quite strange forms. Their appendages also vary. For example, several species in the family Munnopsididae have legs that are up to four times their body length and antennae up to nine times their body length. When these animals move in the water column, they have to swim backwards, dragging their legs and antennae "behind" them. They have been recorded "walking" through the water column with their very long legs spread out in the form of a parachute to stabilise themselves.



Examples of the diversity in asellote body shapes. (a) *Stylomesus sarsi* Merrin & Poore (2003) from the south-eastern Australian continental slope (reproduced with permission from *Memoirs of Museum Victoria*). (b) *Storthyngura magnispinis* (Richardson, 1908) from the north-west Atlantic. (c) *Haploniscus tangaroae* Lincoln (1985), a New Zealand asellote, from off the south-east coast of the South Island.

Explanations of terms in bold

Isopods: isopods are crustaceans, related to crabs and lobsters. They are generally 3–10 mm long (although they can reach 50 mm) and have successfully colonised marine, freshwater and terrestrial environments. Common names include pill bug, slater and sea lice.
Detritivores: an organism which consumes (eats) non-living organic matter.
Endemism: an endemic species is one that is found in one region or location and nowhere else in the world.
Gondwana: the great southern landmass that existed between approximately 80 and 135 million years ago.

Teachers: this article can be used for NCEA Achievement Standards in Biology (2.5, 2.6), Science (2.3). See other curriculum connections at www.niwa.co.nz/pubs/wa/resources

Aggressive isopod relatives

Asellotes are harmless, with no recorded threat to humans or industry, unlike some other isopods – such as *Sphaeroma, Limnoria* and cirolanids, all from the sub-order Flabellifera. Some *Sphaeroma* and *Limnoria* species are wood borers, attacking wooden ship hulls, wharf pilings and oyster stacks on marine farms. They could be termed the termites of the sea, and have been known to destroy unprotected wooden wharf pilings within two years. Wood is not their only target. In New Zealand, gribble (*Limnoria lignorum* Rathke) caused the 1916 failure of the Cook Strait submarine cable when some individuals bored through the guttapercha that was around the inner cable core. Cirolanids are known to attack fish caught in traps and nets, and have caused the collapse of some commercial fisheries. (See *Water and Atmosphere 9(3)*:12–13 for more information.)

Appendix: B

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Review of the deep-water asellote genus *Notopais* Hodgson, 1910 (Crustacea: Isopoda: Munnopsididae) with description of three new species from the south-western Pacific

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Abstract

The munnopsidid genus *Notopais* Hodgson, 1910 is taken out of synonymy with *Echinozone* Sars, 1897. The type species *Notopais spicata* Hodgson, 1910 and *Notopais quadrispinosa* (Beddard, 1886) are redescribed and three new species described: *Notopais beddardi* n. sp. collected from Antarctica at a depth of less than 37 metres; *Notopais minya* n. sp. collected from the south-eastern Australian continental slope between the depths of 429–466 metres; and *Notopais zealandica* n. sp. collected from the Chatham Rise between the depths of 1386–1640 metres, off the south-eastern New Zealand coast. *Notopais* is distinguished from *Echinozone* by three defining characters: the flattened appearance of the ventral side of the cephalon, the presence of pedestal setae on the pereonites and antenna 2 article 1 with produced distolateral angle with prominent spine and distal robust seta. This genus is exclusively found in the Southern Hemisphere and is known from Antarctica and the south-western Pacific.

Key words: Isopoda, Munnopsididae, *Notopais*, Antarctica, Pacific, deep-sea, taxonomy, New Zealand, Australia

Introduction

Notopais Hodgson, 1910 was erected to include the single female specimen of *Notopais spicatus* Hodgson, 1910 which, due to its lack of natatory pereopods was unable to be placed in any existing genus. *Notopais* was placed in the family Munnopsididae Lilljeborg, 1864, which also contained the similar genera *Pseudarachna* Sars, 1897, *Aspidarachna* Sars, 1897, *Echinozone* Sars, 1897 and *Ilyarachna* Sars, 1897. Vanhöffen (1914) later synonymised the monotypic *Notopais* with *Pseudarachna* based on the broadened state of pereopods 5 and 6.

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These four genera were later removed to the then newly created family Ilyarachnidae Hansen, 1916. Wilson (1989) revised the Ilyarachnidae and the closely related families of Munnopsididae and Eurycopidae Hansen, 1916, changing the classification of the Ilyarachnidae and Eurycopidae to subfamilies within the family Munnopsididae.

Hult (1937) synonymised the genera *Echinozone* and *Aspidarachna* with *Ilyarachna*. *Pseudarachna spicata* was referred to as *Ilyarachna spicata* by Wolff (1962) in a key to the *Ilyarachna* species. Hessler & Thistle (1975) reassessed the then known genera of the Ilyarachnidae, reinstating the original four genera of Sars and creating *Bathybadistes* Hessler & Thistle, 1975. Hessler & Thistle (1975) reallocated several species (most of which stand today), and placed *N. spicatus* into synonymy with *Echinozone quadrispinosa* (Beddard, 1886), although no evidence was provided to support their decision. Schultz (1976) also recognised Sars' four genera and, like Brandt (1990), did not acknowledge the paper by Hessler & Thistle (1975) and their synonymy of *N. spicata* with *N. quadrispinosa*. Schultz (1976) transferred *Pseudarachna spicata* to *Echinozone* and described new material collected from Anvers Island. More recently, Brandt (1990) also synonymised *E. spicata* with *E. quadrispinosa*, but provided only limited support for her decision. Neither author referred to the type material of *Notopais spicata* with only Brandt referring to the type material of *E. quadrispinosa*.

In this contribution, *E. spicata* is brought out of synonymy and redescribed from the type material. *E. quadrispinosa* is also redescribed from type material, and a lectotype and paralectotype are designated as the syntypes contained two species. Three new species from Antarctica, Australia and New Zealand are described.

Methods and abbreviations

Illustrations were made using a Nikon Labophot-2 and a Zeiss Stemi SV 11 dissecting microscope, both fitted with a camera lucida. Borrowed type material was redescribed without dissection (conditions of loan) and all appendages were drawn *in situ*. For this reason, setation illustrated on these appendages are approximate. *Notopais beddardi* n. sp. was also described without dissection in order to conserve the only individual of this new species. In order to preserve the holotypes of the other two new species, a paratype was dissected where appendages were present, otherwise limbs were dissected from either an additional paratype or the holotype. Descriptions that were prepared from more than one individual are identified in the figure captions.

Descriptions were prepared using the computer program DELTA (Dallwitz *et al.* 2000). All ratios were calculated using the maximum lengths and widths of segments unless stated otherwise in the text.

Abbreviations used in text are as follows: BS – broom setae; PLS – plumose setae; RFS – robust flagellate setae; RS – robust setae; SS – simple setae; NSW – New South Wales; Tas – Tasmania; Vic – Victoria; BMNH – Natural History Museum, London;

NIWA – National Institute of Water and Atmospheric Research, Wellington; NMV – Museum Victoria, Melbourne; ZMHB – Museum für Naturkunde der Humboldt-Universität, Berlin.

Taxonomy

MUNNOPSIDIDAE Lilljeborg, 1864
Subfamily Ilyarachninae Hansen, 1916

Notopais Hodgson, 1910

Notopais Hodgson, 1910: 69.

Type species *Notopais spicatus* Hodgson, 1910, by monotypy.

Diagnosis: Cephalon frons narrow, allowing for almost horizontal position of maxillipeds *in situ* in lateral view. Pereonites 1–4 anterior margins usually with spines, if not, margins with robust setae; all spines tipped with robust (pedestal) setae, making spines look more pronounced. Antenna 2 article 1 distolateral angle with horn-like prominent spine and terminal robust seta. Mandible palp absent; incisor process large, rounded, without defined cusps; lacinia mobilis reduced or absent. Pereopods 5 and 6 carpus and propodus flat, expanded, margins with plumose setae. Pereopods 7 ambulatory, robust, retains plumose setae similar to pereopods 5 and 6. Uropods biramous.

Description: Body compact, cuticle brittle; cephalon trapezoid, broad, wider posteriorly, dorsal face domed, ventrally, cephalon flattened, frons narrow allowing maxillipeds to appear almost horizontal in lateral view. Pereonites 2–4 anterolateral margins usually with spines, anterior margins usually with spines, if not, margins with robust setae; all spines tipped with robust (pedestal) setae, making spines look more pronounced. Antenna 2 articles 1–4 short, combined length less than half of length of article 5; article 1 distolateral angle with prominent spine, horn-like, and terminal robust seta; article 6 more elongate than 5. Mandible massive, calcareous; palp absent; incisor process large, rounded, without defined cusps; lacinia mobilis reduced or absent. Pereopods 5 and 6 carpus expanded, discoidal, flat; propodus flat, expanded; superior margin of ischium and both margins of carpus and propodus with row of evenly-spaced long plumose setae. Pereopod 7 ambulatory, but more robust and retaining long, plumose setae similar to that of pereopods 5 and 6. Pleon triangular in dorsal view, with domed medial keel. Operculum vaulted, with prominent medial keel. Uropods biramous, small, flat.

Remarks: *Notopais* can be distinguished by: the flattened appearance of its mouthparts *in situ*, pereonites 1–4 anterior margins most commonly with spines or otherwise with robust setae; all spines tipped with robust (pedestal) setae; antenna 2 article 1 with produced anterolateral angle with a distal robust seta; pereopods 5, 6 and 7 with superior mar-

gin of ischium and both margins of the carpus and propodus with row of evenly spaced long, plumose setae; and uropods biramous, small and flat.

On studying Sars' material of *Echinozone coronata* (Sars, 1870) the type species for *Echinozone* genus, it can be found that *Notopais* differs from this genus in cephalon and body shape, the presence of pedestal setae and with the distinct shape of antenna 2 article 1. In *Notopais* the frons is narrower compared with *Echinozone*, allowing the frontal arch to meet up with the maxillipeds at a wider angle, giving them a more horizontal appearance. The more acute angle between the frontal arch and maxillipeds seen in *Echinozone* gives it a much more triangular appearance, especially in lateral view. This structure adds more emphasis on the curvature of the animal and its body is more arched than in *Notopais*. *Notopais* has pedestal setae tipping all of its spines, similar to that found in *Bathybadistes* and these are not present in *Echinozone*. Although many Ilyarachninae (including *Echinozone*) have a robust seta and/or a spine on the anterolateral angle of antenna 2 article 1, the shape of this in *Notopais* is distinct and exclusive to this genus. Its shape is akin to a bull's horn and is always tipped with a robust seta making it more pronounced.

This genus now contains: *Notopais beddardi* n. sp., *N. zealandica* n. sp., *N. minya* n. sp., *N. magnifica* (Vanhöffen, 1914) **comb. nov.**, *N. quadrispinosa* (Beddard, 1886) **comb. nov.**, *N. spicata* Hodgson, 1910 (type species) and *N. spinosa* (Hodgson, 1902) **comb. nov.** The genus appears to be restricted to the Southern Hemisphere, from Antarctic waters to the south-east continental slope of Australia, at depths from 36 to 1640 metres.

Key to the species of *Notopais*

1. Anterior margin of pereonite 5 with large, distinct spines 2
— Anterior margin of pereonite 5 either smooth, with robust setae or small spines only . 3
2. Cephalon with pair of short dorsal spines; pereonite 4 with anterior facing spines set back from anterior margin, most marginal spines on pereonites with body margins; anterolateral margins of pereonites 5 and 6 pointing towards cephalon .... *N. quadrispinosa*
— Cephalon with pair of large, distinct dorsal spines; pereonite 4 with anterior facing spines on anterior margin; all marginal spines on pereonites are well defined and acutely angled; anterolateral margins of pereonites 5 and 6 rounded ..... *N. spicata*
3. Cephalon with dorsal spines; pereonites 1–4 with large spines; anterior margin of pereonite 5 normal, continuous, without overhang 4
— Cephalon with no dorsal spines; pereonites 1–4 with robust setae only, large spines absent; pereonite 5 with anterior margin overhanging pereonite 4 .. *N. zealandica* n. sp.
4 Cephalon with 4 dorsal spines (not including, if present, any on anterolateral margins) 5
— Cephalon with 2 dorsal spines only, no small spines on anterolateral margins; no submarginal lateral spines on pereonite 4; anterior margin of pereonite 5 with stiff robust

setae; antenna 2, articles 1 and 2 distosuperior margin with row of 4 robust setae ....*N. beddardi* n. sp.

5. Pereonites 6–7 dorsal surface with no spines; cephalon with no spines on anterolateral margins 6

— Pereonites 6–7 dorsal surface both with pair of small spines; cephalon anterolateral margins each with single small spine, another pair of spines are set well back from margin but are not on central dome; pereonite 5 anterior margin with 4 small spines .. .. *N. spinosa*

6. Cephalon with 4 spines, which are small enough to be regarded as tubercles; pereonites 2–3 anterior margin with 6 spines; pereonite 5 anterior margin smooth; antenna 2 article 1 only article with distolateral angle with defined spine and terminal robust seta ..... *N. minya* n. sp.

— Cephalon with 4 large, distinct spines, the inner pair larger than outer pair; pereonites 1–4 anterior margins with continuous row of spines (when mature adult); pereonite 5 dorsal surface with pair of rounded domes, one each side of centre, anterior margin smooth *N. magnifica*

Notopais spicata Hodgson, 1910 (Fig. 1)

Notopais spicatus Hodgson, 1910: 70–71, pl. 8, fig. 1.
Pseudarachna spicata.— Vanhöffen, 1914: 593, fig. 126.— Hale, 1937: 43–45, figs 18–19.— Kussakin, 1967: 313–314, fig. 54.
Ilyarachna spicata.— Wolff, 1962: 95.— Amar & Roman, 1974: 579–580, fig. 11.
Echinozone spicata.— Schultz, 1976: 8-10, figs 3–4.
Pseudarachna vanhoeffeni.— Schultz, 1976: 13.
Echinozone quadrispinosa.— Brandt, 1990: 216, fig. 1 (part).

Material Examined.— Holotype. Female (3.0 mm), Winter Quarters, McMurdo Sound, Ross Sea, Antarctica, 77°49'0"S 167°7'4"E, 28 February 1902, inside 20-fathom line (36.6 metres), S.S. *Discovery* (BMNH 1910.3.18.150).

Additional material.— Male (3.0 mm), Gauss Station, Davis Sea, Antarctica, 66°2'S 89°38'E, 12 August 1902 or 19 December 1902, 385 m, *Gauss* (ZMHB 17739).

Description: *Holotype*. Body 2.3 times as long as greatest width (from spine to spine) of pereonite 2; widest at pereonite 2; cuticle not highly calcified, lightly setose. Cephalon smooth, with 2 dorsal spines; posterolateral margins rounded; ridge encompassing antennae with no extension. Pereonites 1–5 anterior margins each with 4 well-developed spines; anterolateral margins of pereonites 1–4 with spines, 5–7 rounded and smooth; pereonites 1–4 with pair of lateral, sub-marginal spines and each with pair of widely spaced, small, dorsal sub-lateral spines.

Antenna 1 broken; article 1 2.1 times as long as wide, dorsal surface concave, with 1 sub-marginal robust flagellate seta, distal margin with 1 flagellate robust and 1 broom seta,

superior margin with 1 simple and 1 broom seta; article 2 0.4 times as long as article 1, 2.0 times as long as wide, distal margin with 1 robust flagellate seta; remaining articles all rectangular, length varying; article 3 with 2 simple setae; article 4 with 1 simple seta; article 6 with 1 distal aesthetasc. Antenna 2 broken, articles 1–2 squat, both wider than long; article 1 superior margin with 2 simple setae; article 2 1.2 times as long as article 1, distolateral angle with spine, terminal robust seta and inferior margin with 1 simple seta; article 3 1.0 times as long as article 1, distolateral angle with spine terminated with robust seta, inferior margin with 2 simple setae and distoinferior margin with 1 short robust seta, 2 flagellate robust setae (long) and 1 simple seta; article 4 small, 0.8 times as long as article 1, not ornamented.

Pereopod 1 basis 7.2 times as long as wide, inferior margin with 4 setae (2 SS, 1 distal RFS, 1 distal RS), lateral face with 3 setae (all SS); ischium 3.8 times as long as wide, inferior margin with 3 setae (all SS), lateral face with 2 setae (both SS); merus 1.3 times as long as wide, inferior margin with 4 setae (all SS), distosuperior margin with 1 seta (SS); carpus 3.8 times as long as wide, inferior margin with 2 setae (both long SS, in proximal half), superior margin with 3 setae (all SS, 1 distal); propodus 4.0 times as long as wide, inferior margin with 8 setae (all SS, on distal half), superior margin with 2 setae (both SS, distal); dactylus 3.3 times as long as proximal width, superior margin with 5 setae (all SS, distal).

Pereopod 7 basis 3.3 times as long as wide, inferior margin with 4 setae (3 SS, 1 RFS), lateral face with 1 seta (SS), superior margin with 3 setae (all SS); ischium 3.5 times as long as wide, inferior margin with 3 setae (all SS, 2 distal), lateral face with 1 seta (SS, distal), superior margin with 3 setae (2 SS, 1 PLS); merus 1.7 times as long as wide, inferior margin with 4 setae (all SS, distal), distosuperior margin with 2 setae (both SS); carpus 3.4 times as long as wide, inferior margin with 8 setae (3 PLS, 3 SS, 2 sub-marginal SS), superior margin with 5 setae (2 SS, 2 sub-marginal SS, 1 distal RFS); propodus 8.3 times as long as wide, inferior margin with 3 setae (all SS), lateral face with 1 seta (SS, proximal), superior margin with 4 setae (all distal, 3 SS, 1 PLS); dactylus 6.0 times as long as proximal width, superior margin with 5 setae (all SS), inferior margin with 1 seta (SS).

Pleon lateral sides indent and posterior end coming to a rounded point, with scattered simple setae. Operculum 2.7 times as long as proximal width, medial keel with robust setae and lateral and distal margin with numerous long setae (unable to identify actual type of setae).

Male: Similar to female in setation and spines although spines are more pronounced. Larger than female. Cephalon posterolateral margin squarer than in female, reaching beyond anterolateral margin of pereonite 1. Ventrally, frons not as narrow as in female (female not illustrated in lateral view), mouthparts not complete, so unable to comment on their position. Pereonite 4 anterolateral margin and pereonite 5 posterolateral margin with pair of robust setae; pereonites 1–5 anterior margins higher than in female; pereonites 5–7 not as rounded as in female. Pleon 1.1 times as long as proximal width.

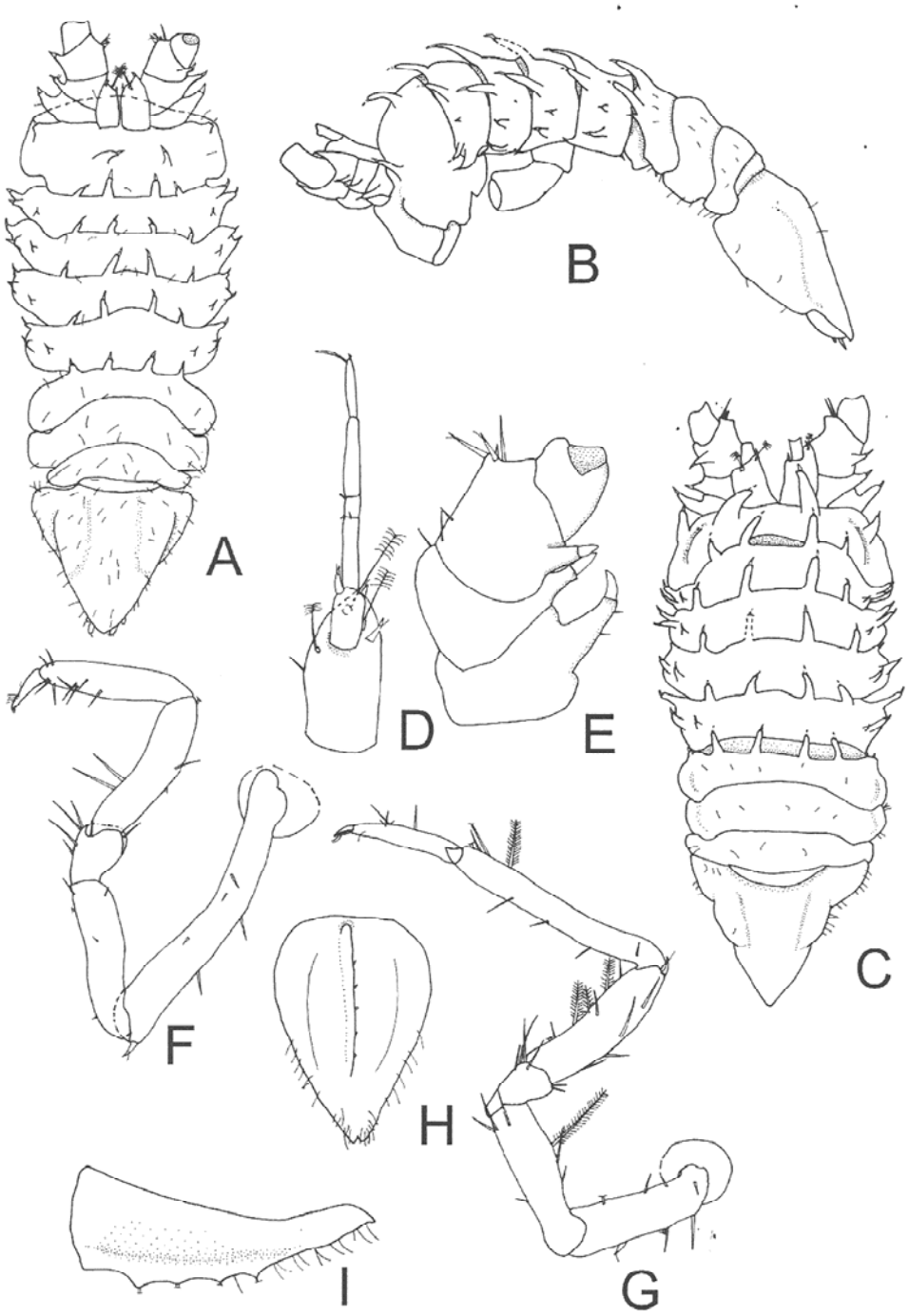

FIGURE 1. *Notopais spicata* Hodgson, 1910. A, D–I, female holotype, 3.0 mm; B, C, Vanhöffen's specimen, male, 3 mm. A, dorsal view; B, lateral view; C, dorsal view; D, left antenna 1; E, right antenna 2; F, right pereopod 1; G, left pereopod 7; H, operculum; I, operculum, lateral view.

Remarks: *Notopais spicata* is distinguished by the prominent spines on the anterior margins of the first 5 pereonites and the single spine on each of the first three articles of antenna 2. This species was previously considered to be a junior synonym of *N. quadrispinosa* by Hessler & Thistle (1975) and Brandt (1990). After redescribing the type material for both species, it is clear that they are distinct. The spines on the cephalon and anterior margins of the first five pereonites of *N. spicata* are more strongly produced and more acute than those of *N. quadrispinosa*; the anterior spines on the fourth pereonite are set back from the anterior margin of *N. quadrispinosa* while in *N. spicata* these spines are on the absolute anterior margin; and the shape of pereonites 5–7 differs markedly between the two species, in *N. spicata* the lateral margins are rounded and in *N. quadrispinosa*, the anterolateral margins are pointed towards the cephalon. The arrangement of spines and robust setae on both antennae is another character that one can use to distinguish the two species. Robust setae feature much more prevalently on the antennal article margins of *N. quadrispinosa*.

Schultz (1976) redescribed *N. spicata* from material collected from Antarctica. Schultz also assessed the illustration and description by Vanhöffen (1914) and created a new species *Pseudarachna vanhoeffeni* (incorrectly labelled new combination). This species was based on Vanhöffen's description, which stated that it only has one uropodal ramus. Examination of Vanhöffen's specimen revealed that the uropod is biramous, the exopod is minute, and may quite easily be overlooked. The name is considered to be a junior synonym of *N. spicata*.

Distribution: Antarctica, eastwards from the Prince Olav coast to the Anvers Islands, including the areas of the Davis and Ross Seas, from 36.6–560 metres.

***Notopais quadrispinosa* (Beddard, 1886), comb. nov. (Fig. 2)**

Ilyarachna quadrispinosa Beddard, 1886: 76–78, pl. 12, figs 2–6.— Nordenstam, 1933: 266–273, fig. 77.— Stephensen 1947: 8.— Wolff, 1962: 95.— Amar & Roman, 1974: 579.
Echinozone quadrispinosa.— Kussakin, 1967: 312.— Schultz, 1976: 4–5.— Kussakin & Vasina, 1982: 326, fig. 29.— Brandt, 1990: 216–218, fig. 1 (part).

Material examined.— Lectotype (here designated). Ovigerous female (6.0 mm), Station 149H, off Cumberland Bay, Kerguelen Island, southern Indian Ocean, 48°45'S 69°14'E, 29 January 1874, 127 fathoms (232 m), volcanic mud, HMS *Challenger* (BMNH 1889.4.27.73).

Additional material.— Paralectotype (here designated). Female (pereonites 5–7 and pleon only, 2.0 mm) Station 149H, off Cumberland Bay, Kerguelen Island, southern Indian Ocean, 48°45'S 69°14'E, 29 January 1874, 127 fathoms (232 m), volcanic mud, HMS *Challenger* (BHNM 2004.676).

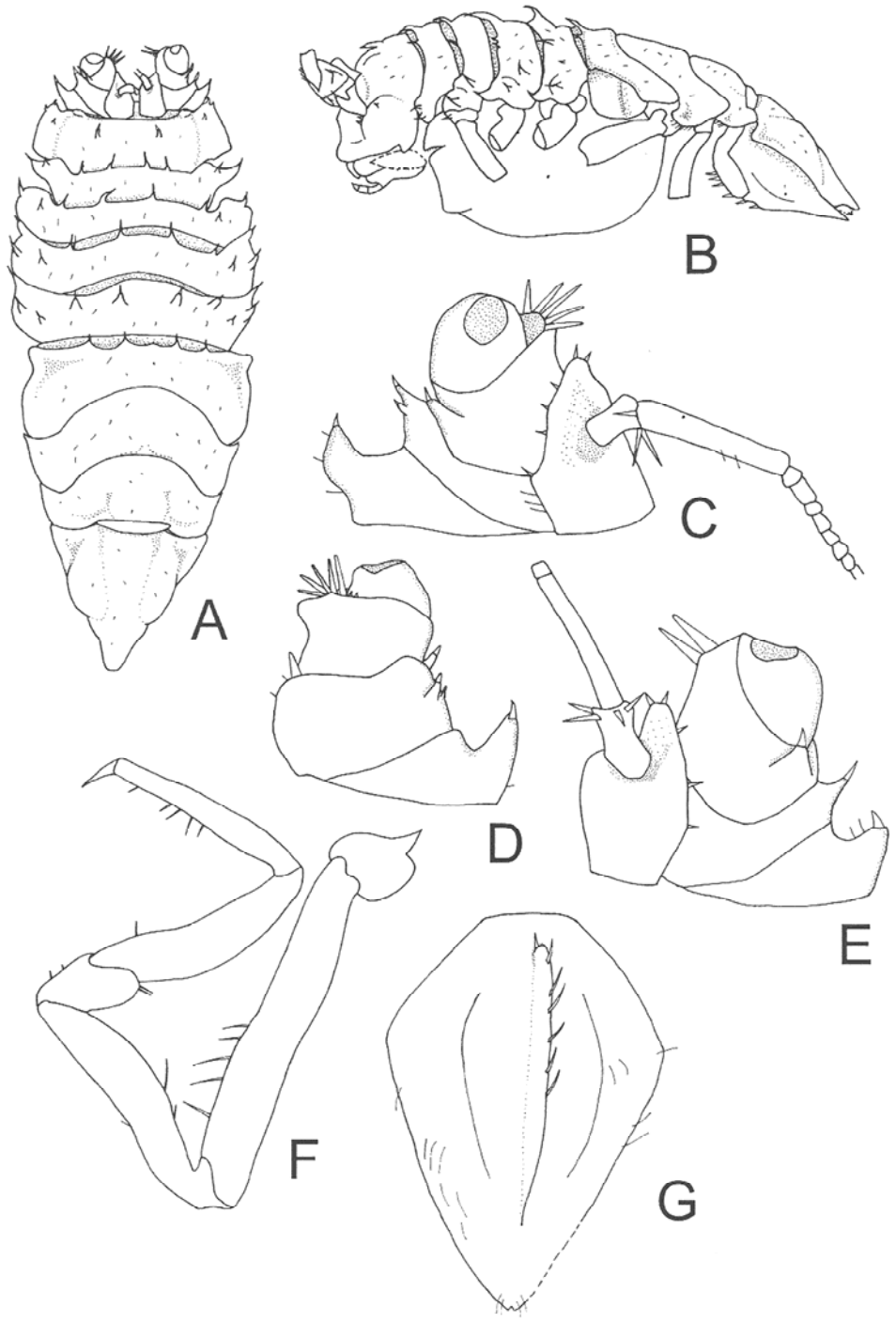

FIGURE 2. *Notopais quadrispinosa* (Beddard, 1886). Female lectotype, 6.0 mm. A, dorsal view; B, lateral view; C, left antenna 1 and 2, dorsal view; D, left antenna 2, ventral view; E, right antenna 1 and 2; F, left pereopod 1; G, operculum.

Description: *Lectotype*. Body 2.4 times as long as greatest width (from spine to spine) of pereonite 2; widest at pereonite 3; cuticle not highly calcified, lightly setose. Cephalon smooth, with 2 dorsal spines; anterolateral margins each with 2 small spines and 1 small sub-marginal spine; posterolateral margins rounded; ridge encompassing antennae, with poorly developed extensions near first articles of antennae. Pereonites 1–3 and 5 anterior margins each with 4 well developed spines; pereonite 4 still with 4 well developed spines, but set back from anterior margin; pereonites 5–7 anterolateral margins pointing towards cephalon; pereonites 3 and 4 only with pair of lateral, sub-marginal spines; pereonites 1–4 each with pair of widely spaced, small, dorsal spines near lateral margins.

Antenna 1 of 11 articles (at least, number refers to what could actually be seen); article 1 distal end triangular, 1.5 times as long as wide, dorsal surface forms shallow depression, distal margin has 2 robust setae, superior margin with 3 simple setae (in proximal half) and 4 robust setae (evenly spaced); article 2 0.3 times as long as article 1, 2.0 times as long as wide with 4 robust setae (at least, all evenly spaced around distal margin); remaining articles all rectangular, length varying; article 3 with 2 simple setae (at least). Antenna 2 article 1 with 3 simple setae; article 2 1.1 times as long article 1, distolateral angle with 2 spines, one smaller than other, both with terminal robust seta, distoinferior margin with 1 robust and 2 simple setae; article 3 0.9 times as long as article 1, distolateral angle with spine terminated with 1 robust seta, distoinferior margin with 5 long robust and 2 short robust setae in a clump; article 4 small, 0.3 times as long article 1, with no ornamentation.

Pereopod 1 basis 6.3 times as long as wide, inferior margin with 5 setae (all SS); ischium length 4.7 times as long as wide, inferior margin with 1 seta (SS), superior margin with 2 setae (both SS); merus 1.2 times as long as wide, inferior margin with 2 setae (both SS), distosuperior margin with 2 setae (both SS); carpus 4.1 times as long as wide, inferior margin with 1 seta (SS proximal); propodus 7.5 times as long as wide, inferior margin with 5 setae (all SS); dactylus 2.3 times as long as proximal width.

Pleon 0.9 times as long as proximal width, lateral sides rounded and posterior end coming to a rounded point, with scattered simple setae. Operculum 4.0 times as long as proximal width, medial keel with proximal facing robust setae and surface, and lateral and distal margins with few scattered long setae (unable to determine actual type).

Remarks: *N. quadrispinosa* can be distinguished by the distinctive setation on the antennae, four spines on the anterior margin of pereonites 1–3 and 5 in conjunction with pereonite 4 where the spines are set back from the absolute margin. For further morphological discussion please read the previous remarks section for *N. spicata*.

Distribution: Antarctica, reliably known from the Crozet Islands to the Leopold and Astrid Coast, from 168–245 metres.

***Notopais beddardi* n. sp. (Fig. 3)**

Material examined.— Holotype. Female (4.0 mm), Station 149H, off Cumberland Bay,

Kerguelen Island, southern Indian Ocean, 48°45'S 69°14'E, 29 January 1874, 127 fathoms (232 m), volcanic mud, HMS *Challenger* (BMNH 2004.677).

Description: *Holotype*. Body 2.4 times as long as greatest width (from spine to spine) of pereonite 2; widest at pereonite 4; cuticle not highly calcified, lightly setose. Cephalon lightly setose with 2 dorsal spines; posterior margins rounded, but almost square; ridge encompassing antennae with no extension. Pereonites 1–4 anterior margins each with 4 well developed spines; pereonite 5 anterior margin with evenly spaced stiff simple setae; pereonite 5 with anterolateral margin rounded; pereonites 1–4 anterolateral margins with spines, 5–7 rounded and smooth; pereonites 1–4 each with pair of lateral, sub-marginal spines.

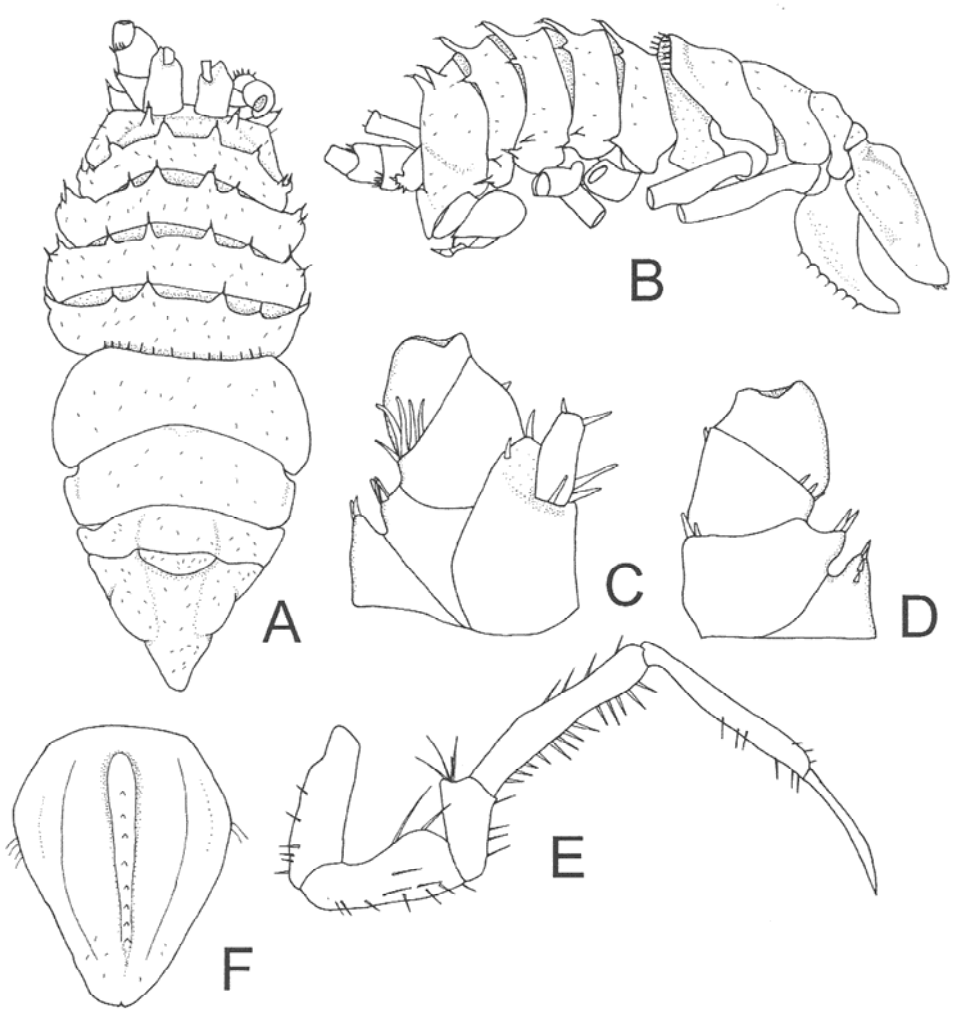

FIGURE 3. *Notopais beddardi* n. sp. Female holotype, 4.0 mm. A, dorsal view; B, lateral view; C, left antenna 1 and 2, dorsal view; D, left antenna 2, ventral view; E, right pereopod 2; F, operculum.

Antenna 1 article 1 rectangular and elongate, 1.7 times as long as wide, dorsal surface concave and forms shallow depression, distal margin with 5 robust setae; article 2 elongate, 0.4 times as long as article 1, 2.4 times as long as wide, with 2 robust setae (distal). Antenna 2 articles 1–3 more or less triangular; article 1 spine on distolateral angle with 3 additional robust setae on ventral side; article 2 inferior margin 1.2 times as long as article 1, distolateral angle with spine and 4 terminal robust setae, distoinferior margin with 2 robust setae; article 3 inferior margin 1.3 times as long as article 1, with 5 long robust and 3 short robust setae on distosuperior rim of article, distoinferior margin with 1 robust seta; article 4 small, 0.6 times as long as article 1, with no ornamentation.

Pereopod 2 basis 2.7 times as long as wide, inferior margin with 6 setae (all SS); ischium 2.1 times as long as wide, inferior margin with 7 setae (1 SS, 6 sub-marginal SS), lateral face with 3 setae (all SS), superior margin with 2 setae (both SS, in distal half); merus 1.7 times as long as wide, inferior margin with 4 setae (all SS), distosuperior margin with 4 setae (all SS); carpus 6.0 times as long as wide, inferior margin with 13 setae (all RS, evenly spaced), superior margin with 4 setae (all SS, in distal half); propodus 8.2 times as long as wide, inferior margin with 6 setae (all SS), superior margin with 3 setae (all SS, distal half); dactylus 9.7 times as long as proximal width.

Pleon 0.6 times as long as proximal width, lateral sides rounded and posterior end coming to a rounded point, with scattered simple setae. Operculum 1.9 times as long as proximal width, medial keel with evenly spaced downward facing robust setae, lateral margins and distal surface with few setae (unable to determine actual types).

Remarks: *Notopais beddardi* n. sp. can be identified by the combination of having only two dorsal spines on the cephalon; anterior facing marginal spines on only the first four pereonites, with robust setae on the corresponding margin of the fifth; the unique setal combinations of the first two articles in antenna 1 and the first three articles in antenna 2; the rounded anterior margin of pereonite 5; and the anterolateral margins of pereonites 5 and 6 rounded and smooth, and not coming to a point. The spines on the anterior margin of article 4 on *N. beddardi* are set on the absolute anterior margin, similar to that seen in *N. spicata* (although they are not as pronounced or as acutely angled) instead of almost being dorsal as is in *N. quadrispinosa*. *N. beddardi* does not have anterior spines on the fifth pereonite as in *N. quadrispinosa*, instead it has a row of short stout setae. The shape of pereonites 5–7 also differs between the two species. In *N. beddardi* these pereonites are broader than those in *N. quadrispinosa*. Pereonite 5 in *N. beddardi* has a rounded anterolateral margin, and the corresponding margins of pereonites 6 and 7 are not as acute as those in *N. quadrispinosa*. The spination of both antennae are also different between the two species. The first article of antenna 1 in *N. beddardi* has long robust setae around the distal margin, while *N. quadrispinosa* has robust setae along the superior margin. The number of robust setae on the spines of the first two antennal articles of antenna 2 also differ, with *N. beddardi* having many more robust setae on the distosuperior margins than in *N. quadrispinosa* which has a single robust seta terminating each spine. The position of

robust setae on the distal margin of the article 3 of antenna 2 also differs between the two species, with those of *N. beddardi* being on the superior margin, while on *N. quadrispinosa* they are on the inferior margin.

Distribution: Known only from type locality, off Kerguelen Island, southern Indian Ocean.

Etymology: For Frank E. Beddard, the distinguished biologist, who described the many isopods which were collected during the *Challenger* expedition of 1873–1876.

***Notopais minya* n. sp. (Figs 4–7)**

Material examined.— All material from eastern Australia. Holotype. Ovigerous female (5.0 mm), Stn SLOPE 56, 44 km E of Nowra, NSW, from 34°55.79'S 151°08.06'E to 34°56.06'S 151°07.86'E, 22 October 1988, WHOI epibenthic sled, muddy coarse shell, 429–466 m, G.C.B. Poore et al., R.V. *Franklin* (NMV J52877). Paratypes. 69 males, 91 females, 9 fragments (between 2.0–5.5 mm; 1 male, 3 mm and 2 females, 4.0 mm and 4.5 mm, dissected), type locality (NMV J52876).

Additional material.— 2 males, 2 females, 2 fragments, 79-K-1 Stn 32, shelf, eastern Bass Strait, 39°41.7'S 148°39.5'E, 27 March 1979, dredge, muddy sand, 115 m, G.C.B. Poore, HMAS *Kimbla* (NMV J18851). 4 males, 5 females, 1 fragment, Stn SLOPE 2, off Nowra, NSW, 34°57.9'S 151°8.0'E, 14 July 1986, WHOI epibenthic sled, in bryozoa and shell, 503 m (bottom), G.C.B. Poore et al., R.V. *Franklin* (NMV J18847). 2 females, Stn SLOPE 19, off Eden, NSW, 37°07.3'S 150°20.2'E, 20 July 1986, WHOI epibenthic sled, grey coarse shell, 520 m (bottom), G.C.B. Poore et al., R.V. *Franklin* (NMV J18848). 1 female, Stn S05/84/64, 15 km E of Cape Connella, Tas, 43°24.6'S 147°32.5'E, 22 October 1984, WHOI epibenthic sled, 82 m, R. Wilson, R.V. *Soela* (NMV J18874). 1 female, 79-K-1 Stn 33, Flinders Canyon, eastern Bass Straight, 39°40.3'S 148°46.5'E, 27 March 1979, dredge, coarse shell, 293–329 m, G.C.B. Poore, HMAS *Kimbla* (NMV J18852). 2 males, 4 females, 3 fragments, Stn SLOPE 1, off Nowra, NSW, 34°59.52'S 151°5.94'E, 14 July 1986, WHOI epibenthic sled, coarse shell, 204 m (bottom), G.C.B. Poore et al., R.V. *Franklin* (NMV J18846). 1 female, Stn SO5/84/29, Tasman Sea, eastern slope, 70 km S of Gabo Island, Vic, 38°10.3'S 149°57.2'E, 14 October 1984, WHOI epibenthic sled, 592 m, R. Wilson, R.V. *Soela* (NMV J18854). 1 female, Stn SO5/84/30, Tasman Sea, eastern slope, 50 km S of Mallacoota, Vic, 38°06.2'S 149°45.5'E, 14 October, 1984, WHOI epibenthic sled, 188 m, R. Wilson, R.V. *Soela* (NMV J18855). 2 males, 7 females, 6 fragments, Stn SLOPE 40, south of Point Hicks, Vic, 38°17.7'S 149°11.3'E, 24 July 1986, WHOI epibenthic sled, coarse sand, gravel and mud, 400 m (bottom), M.F. Gomon et al., R.V. *Franklin* (NMV J18849). 3 males, 4 females, 79-K-1 Stn 35, shelf, eastern Bass Straight, 39°28.4'S 148°41.8'E, 28 March, 1979, dredge, shell and sand, 110 m, G.C.B. Poore, HMAS *Kimbla* (NMV J18853).

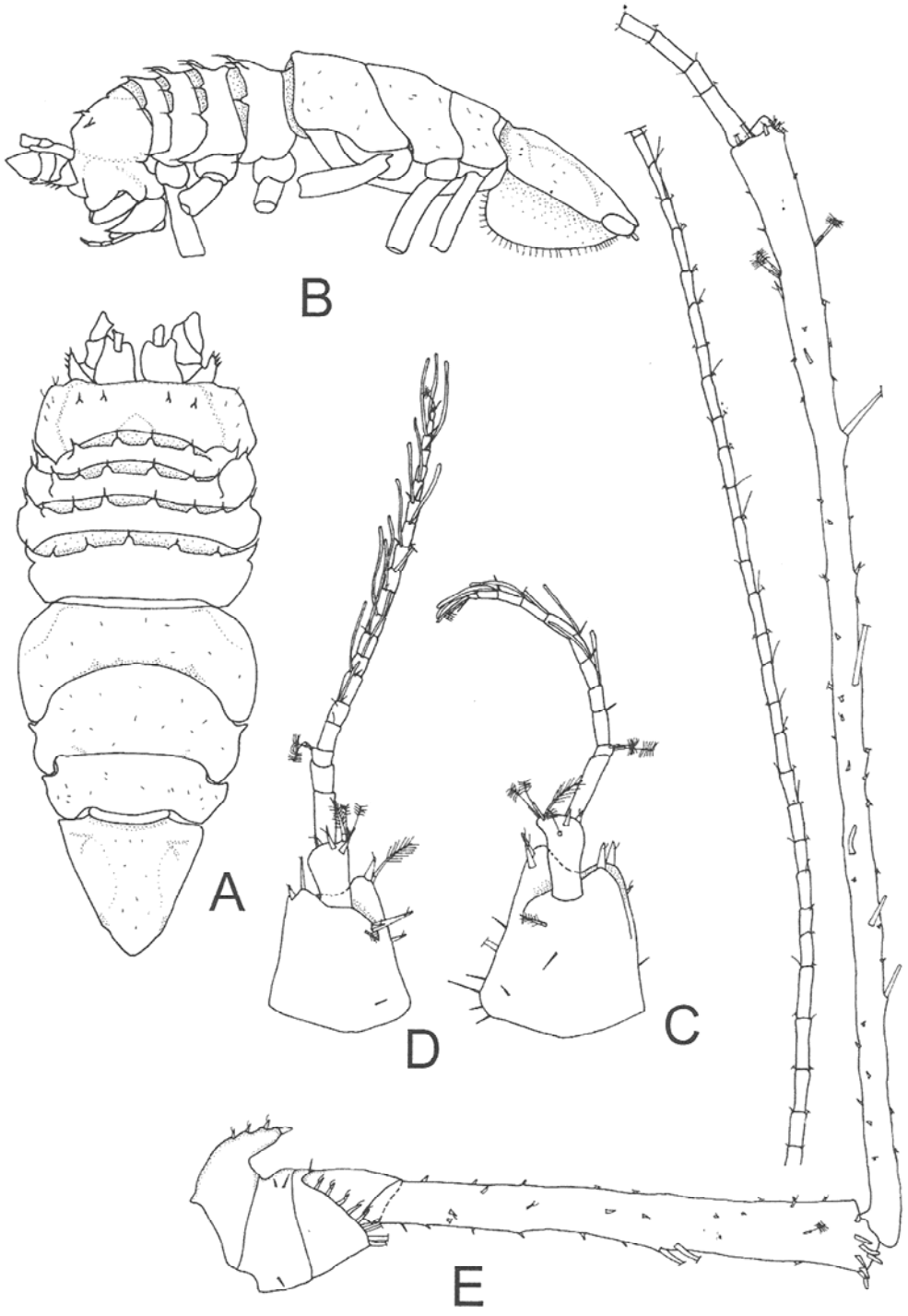

FIGURE 4. *Notopais minya* n. sp. A, B, female holotype, 5.0 mm; C and E, female paratype, 4.0 mm; D, male paratype, 4 mm. A, dorsal view; B, lateral view; C, left antenna 1; D, right antenna 1; E, right antenna 2.

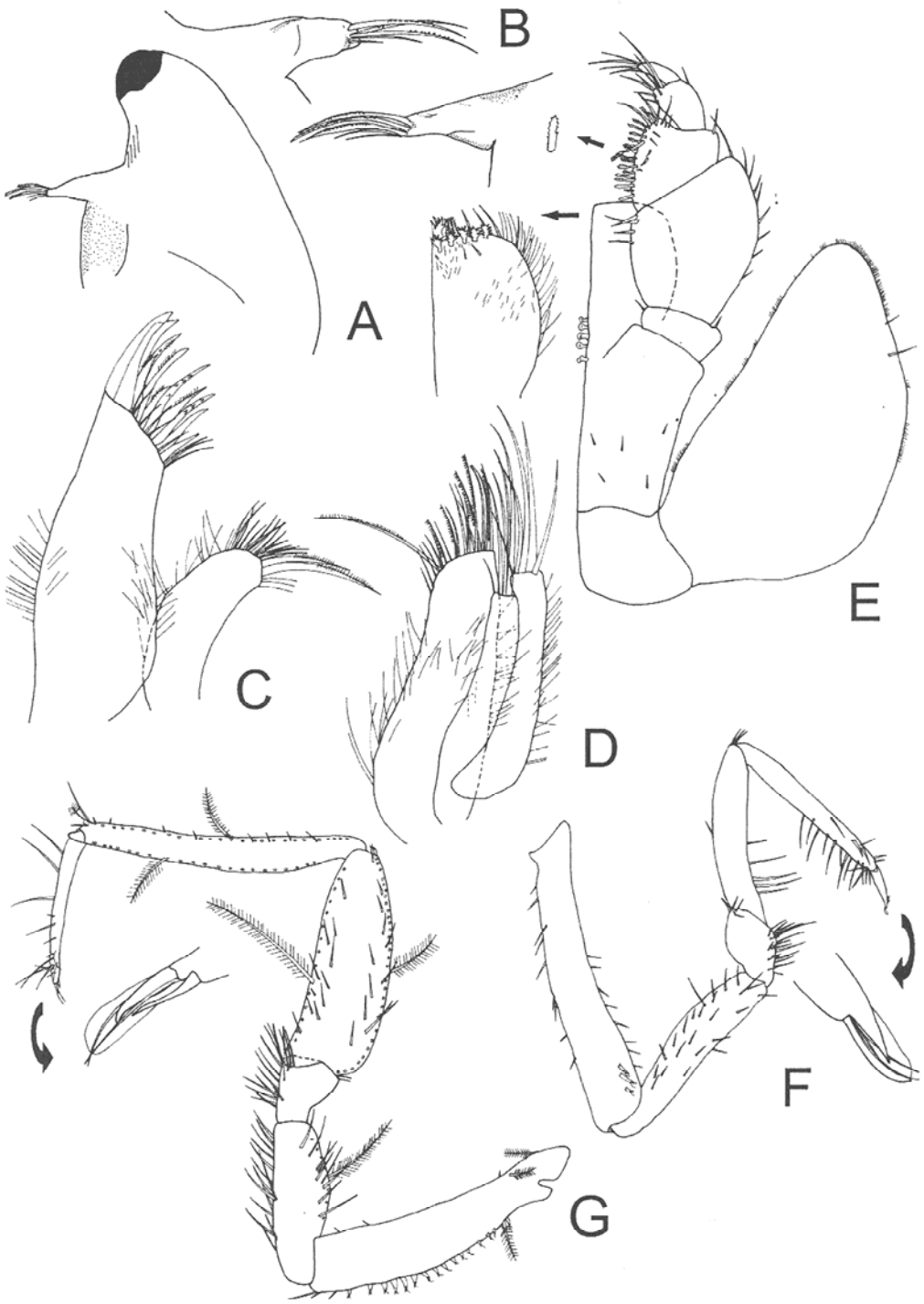

FIGURE 5. *Notopais minya* n. sp. All figures from female paratype. A, left mandible; B, left mandibular molar (top) and right mandibular molar (bottom); C, right maxilla 1; D, left maxilla 2; E, left maxilliped; F, left pereopod 1; G, right pereopod 7.

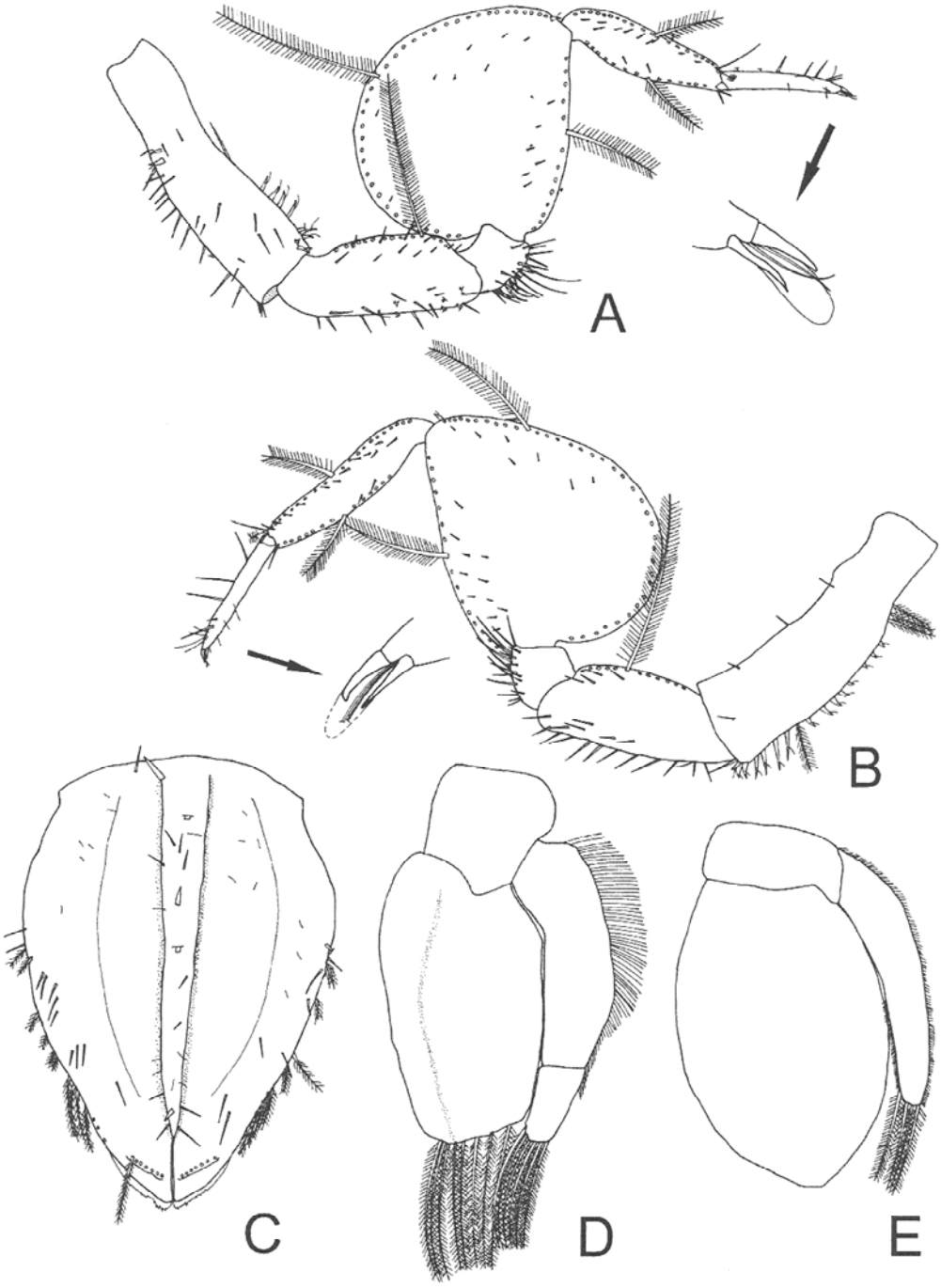

FIGURE 6. *Notopais minya* n. sp. All figures from female paratypes, operculum only from female paratype 4.5 mm. A, left pereopod 5; B, right pereopod 6; C, operculum; D, left pleopod 3; E, left pleopod 4.

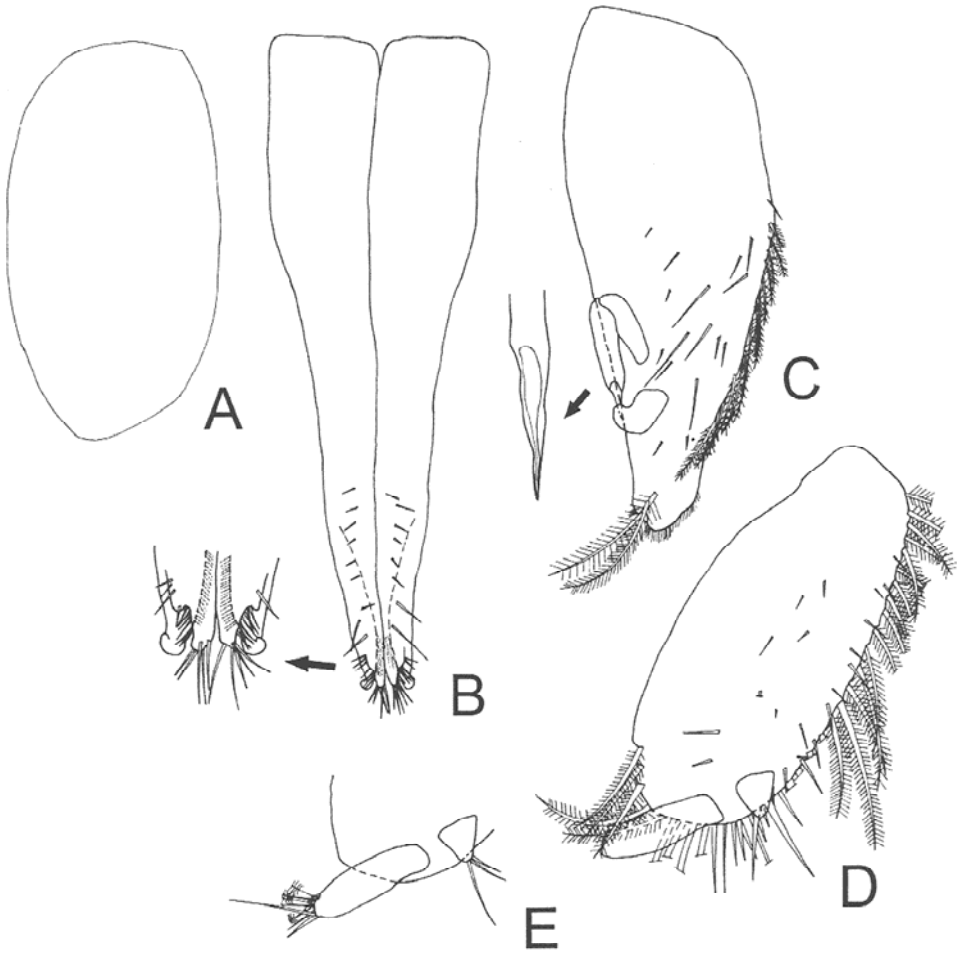

FIGURE 7. *Notopais minya* n. sp. A, D and E, female paratype; B, C, male paratype. A, left pleopod 5; B, pleopod 1; C, left pleopod 2; D, left uropod; E, enlargement of distal part of left uropod.

Description: *Holotype*. Body 2.5 times as long as greatest width (from spine to spine) of pereonite 2; widest at pereonite 3; cuticle not highly calcified, lightly setose. Cephalon lightly setose with 4 spines; anterior margins with few small, simple setae; posterolateral margins broadly rounded; ridge encompassing antennae, with no extension. Pereonite 1 anterior margin with 4 well developed spines, pereonites 2 and 3 with 6 and pereonite 4 with 5; pereonite 5 anterior margin rounded; anterolateral margins of pereonites 6 and 7 with small lobes, facing anteriorly.

Paratypes. Antenna 1 of 13 articles; article 1 distal end rounded, concave in centre, 1.1 times as long as wide, inferior margin with 1 simple and 1 flagellate robust seta, medial

surface with 2 simple setae, 1 broom seta and 4 flagellate robust setae, superior margin with 5 simple seta and 1 robust seta (broken); article 2 elongate, 0.5 times as long as article 1, 1.9 times as long as wide, with 2 robust flagellate setae and 4 broom setae; remaining articles all rectangular; article 4 with 2 broom setae; article 5 with 1 simple seta; from article 6 onwards, each article has 1 aesthetasc, many articles having additional simple setae; terminal article with 1 small simple seta and 1 broom seta. Male antenna 1 similar, of 22 articles; article 1 and 2 ratios similar to female, article 1 superior margin with 3 robust flagellate setae (1 long, 2 short) and 1 broom seta (in clump with robust flagellate setae), distal margin with 3 robust flagellate setae and 1 broom seta; article 2 1.6 times as long as wide, distal margin with 3 robust flagellate setae and 3 broom setae; article 5 with 2 broom setae; from article 8 onwards each article has 1 aesthetasc and many having additional simple setae. Antenna 2 articles 1–3 more or less triangular; article 1 superior margin with 3 additional robust flagellate setae; article 2 0.6 times as long as article 1, with 3 simple seta; article 3 0.6 times as long as article 1, with 1 simple seta and 9 flagellate robust setae (3 broken), all around lateral angled rim of article; article 4 small, 0.8 times as long as article 1, with no ornamentation; article 5 4.6 times as long as article 1, inferior margin with 1 simple seta (proximal end), 6 robust setae (evenly spaced), 2 long robust setae (at midpoint) and mesial face with 4 robust setae, 3 robust flagellate setae and 1 broom seta (at distal end), superior margin with 7 robust setae and 2 flagellate robust setae, distal margin with 8 blunt robust setae; article 6 10.3 times as long as article 1, inferior margin with 14 robust setae, 2 robust flagellate setae, 2 broom setae (distal) and 4 long robust setae, mesial face with 9 robust setae, 2 robust flagellate setae and 2 long robust setae, superior margin with 9 robust setae, 2 robust flagellate setae, 2 broom setae (distal), distal margin with 4 robust flagellate setae and 3 robust setae; flagellum of 33 articles (present, flagellum not complete), each setose.

Left and right mandible identical; mandible without microtrichs; spine row absent; molar small, terminated with 3 uni-serrate setae and 2 simple setae. Maxilla 1 lateral lobe 1.9 times as wide as mesial lobe, lateral and mesial margins with fine simple setae, distal margin with numerous simple setae, 5 robust setae, 3 robust dentate setae and 4 robust semi-plumose setae; mesial lobe with fine simple setae on margins, terminated with 15 simple setae and 2 long pectinate setae. Maxilla 2 lateral lobe with scattered fine simple setae, distally with 1 smaller and 4 long simple setae; middle lobe 1.1 times as wide as lateral lobe, distally with 4 long simple setae and 1 smaller simple seta; mesial lobe 3.4 times as wide as lateral lobe, margins with fine simple setae, terminated with 14 simple setae, 5 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, small, 0.9 times as long as wide, 0.3 times as long as basis (including endite); basis elongate, length including endite 2.6 times as wide, with 5 simple setae (proximal); endite with 5 coupling hooks, and distally with 3 simple setae, 3 toothed setae, 6 fan setae (5 small, 1 large), and many fine simple setae; palp wider proximally, tapers distally, article 1 wide, rectangular, shortest, 0.1 times as long as basal endite, anterolateral margin with 1 simple seta, anteromesial

margin with 1 simple seta; article 2 5.1 times as long as, and 1.6 times as wide as article 1, and 1.6 times as wide as basal endite, superior margin with 9 simple setae (evenly spaced), and inferior margin with 4 simple setae (distal end); article 3 2.7 times as long as, and 0.9 times as wide as article 1, with 1 simple seta on superior margin (distal), inferior margin with 12 simple setae, and 17 semi-fan setae; article 4 almost rectangular, 1.6 times as long as, and 0.5 times as wide as article 1, superior margin with 1 simple seta (distal), and distal margin with 7 simple setae (inferior side); article 5 rectangular, small, narrowest of all articles, 1.3 times as long as, and 0.2 times as wide as article 1, with 6 terminal simple setae; epipod elongate, 1.8 times as long as wide, and 1.1 times as long as basis length, with many microtrichs on margin.

Pereopod 1 basis 6.5 times as long as wide, inferior margin with 9 setae (all SS), lateral face with 3 setae (all distal RFS), superior margin with 8 setae (all SS); ischium 4.3 times as long as wide, inferior margin with 2 setae (both SS), lateral face with 22 setae (all SS, scattered); merus 0.8 times as long as wide, inferior margin with 19 setae (all SS, of varying lengths, scattered), distosuperior margin with 5 setae (all SS); carpus 5.0 times as long as wide, inferior margin with 5 setae (long SS, proximal half), superior margin with 4 setae (all SS, 1 at midpoint, 3 at most distal corner); propodus 9.8 times as long as wide, inferior margin with 14 setae (all SS, in distal half), lateral face with 3 setae (all SS, in distal half), superior margin with 3 setae (all SS, in distal corner); dactylus 4.5 times as long as proximal width, superior margin with 4 setae (all SS, on distosuperior margin).

Pereopod 5 basis 3.4 times as long as wide, inferior margin with 18 setae (16 SS, 3 on distal corner, 2 proximal, sub-marginal RFS), lateral face with 13 setae (12 scattered SS, 1 RFS at distal end), superior margin with 8 setae (2 SS and 6 RFS, all in distal half); ischium 2.4 times as long as wide, inferior margin with 13 setae (all SS, 6 marginal, 7 sub-marginal), lateral face with 12 setae (all SS), superior margin convex, with 6 setae (5 sub-marginal SS, 1 distal SS); merus 0.9 times as long as wide, inferior margin with 22 setae (all SS, of varying lengths); carpus 3.6 times as long as wide, lateral face with 14 setae (all SS, scattered), superior margin with 1 seta (RFS, distal corner); propodus slightly expanded, 3.6 times as long as wide, inferior margin with 4 setae (all SS, 2 on distal margin, 2 sub-marginal), superior margin with 12 setae (10 sub-marginal SS, 1 long SS and 1 BS on distal corner); dactylus 6.3 times as long as proximal width, with 12 setae (all SS, all but 3 on superior margin).

Pereopod 6 basis thicker compared with basis in pereopod 5, 3.4 times as long as wide, inferior margin with 30 setae (25 RFS, 4 PLS, 1 distal SS), lateral face with 1 seta (distal SS), superior margin with 3 setae (all SS); ischium similar to that of pereopod 5, although 2.2 times as long as wide, inferior margin with 17 setae (all SS, 11 marginal, 6 sub-marginal), superior margin with 4 setae (all SS, sub-marginal in distal half); merus distosuperior margin cup-shaped, with carpus inserted into it, length 0.8 times as long as wide, inferior margin with 19 setae (all SS, of varying lengths); carpus similar to that of pereopod 5, 1.2 times as long as wide, lateral face with 18 setae (all SS, scattered); propodus

similar although more elongate than in pereopod 5, 4.4 times as long as wide, also inferior margin with 3 setae (all SS), superior margin with 12 setae (all SS); dactylus similar to that in pereopod 5, although 9.3 times as long as proximal width, with 13 setae (all SS, all but 3 on superior margin).

Pereopod 7 basis 4.6 times as long as wide, inferior margin with 21 setae (17 RFS, 1 proximal PLS, 3 distal SS), superior margin with 5 setae (3 short SS, 2 PLS at proximal end); ischium 2.5 times as long as wide, inferior margin with 14 setae (all SS), superior margin with 9 setae (all sub-marginal SS); merus 1.1 times as long as wide, inferior margin with 18 setae (all SS, of varying lengths), distosuperior margin with 2 setae (both SS); carpus 2.8 times as long as wide, inferior margin with 11 setae (all sub-marginal SS), superior margin with 13 setae (12 sub-marginal SS, 1 RFS at distal corner); propodus 8.6 times as long as wide, superior margin with 13 setae (11 sub-marginal, evenly spaced SS, distal corner with 1 long SS and 1 BS); dactylus 8.5 times as long as proximal width, with 14 setae (all SS, scattered along superior margin).

Pleon 0.9 times as long as proximal width, posterior tip rounded, with scattered simple setae. Male pleopod 1 2.9 times as long as proximal width, lateral margins indent 0.3 from proximal end, either side of centre margin with 17 simple setae (9+8), distally with pair of lobes which go over distolateral horns, with 29 simple setae (14+15). Male pleopod 2 sympod 2.5 times as long as wide, superior margin with 1 simple seta and 15 plumose setae, lateral surface with 16 simple setae (scattered), distal margin with 2 plumose setae and fringe of fine setae; exopod elongate and oval, length 0.1 times as long as sympod; stylet 0.3 times as long as sympod, terminating to a point, sperm duct 0.2 times as long as stylet. Operculum large, 1.8 times as long as proximal width, distally with medial slit and veined lamellar extension, median keel provided with a row robust and simple setae, distal surface with 14 plumose setae (7+7) and entire face with scattered simple setae of varying lengths, lateral margins with numerous plumose setae. Pleopod 3 exopod narrowing, 1.0 times as long as endopod, with row of fine simple setae and distally with 6 long plumose setae; endopod 1.7 times as long as wide, endopod with 8 long plumose setae. Pleopod 4 exopod slender, shorter than endopod, with its distal point at 0.7 times length of endopod, superior and inferior margin (part) with fringe of fine simple setae, with 4 terminal long plumose setae; endopod oval, 1.4 times as long as wide. Pleopod 5 1.8 times as long as wide.

Uropod protopod elongate, 2.3 times as long as wide, margins subparallel, distal end rounded, smooth, lateral margin with 19 plumose setae (4 broken) and 20 simple setae, mesial margin with 5 plumose setae, surface with 17 scattered simple setae; exopod small, 0.1 times as long as protopod and 0.4 times as long as endopod, with 3 simple setae; endopod 0.3 times as long as protopod, with 4 simple and 4 broom setae.

Remarks: Notopais minya n. sp. shows some resemblance to *N. magnifica* although it does not have as many spines on its first four pereonites as has *N. magnifica*. *N. minya* also has only 4 small spines on its cephalon instead of the 2 large dorsal and 2 smaller ones

seen on the anterolateral angles of *N. magnifica*. *N. minya* also has a unique setation pattern on the first four articles of antenna 2. Unlike all other *Notopais* described in this paper, article 2 has no distolateral spine. Pereonites 5–7 are similar to that of *N. beddardi*, except the anterolateral margins on pereonite 6 are more acute.

Distribution: South-eastern Australia, from Nowra, New South Wales to Eastern Bass Strait, depths from 110–592 metres.

Etymology: Minya is an Aboriginal word meaning small.

***Notopais zealandica* n. sp. (Figs 8–10)**

Material examined.— Holotype. Female (4.5 mm), Stn S150, Chatham Rise, New Zealand, 45°46.0'S 174°24.5'E, 26 October 1979, epibenthic sled, 1640 m, R.V. *Tangaroa* (NIWA 3303). Paratypes. 1 male (3.0 mm, part remaining only, pleon missing), 5 females (3.5 [dissected], 3.5, 4.0, 4.5 [dissected], 4.8 mm), Stn S153, Chatham Rise, New Zealand, 45°21.1'S 173°35.8'E, 27 October 1979, epibenthic sled, 1386 m, R.V. *Tangaroa* (NIWA 3304).

Additional material.— 2 fragments, Stn S153, Chatham Rise, New Zealand, 45°21.1'S 173°35.8'E, 27 October 1979, epibenthic sled, 1386 m, R.V. *Tangaroa* (NIWA 3331).

Description: *Holotype*. Body 2.1 times as long as width of pereonite 2 (from spine to spine), widest at pereonite 5; cuticle not highly calcified, smooth. Cephalon smooth; anterior margins with few small, simple setae; posterolateral margins broadly rounded; antennal ridge with poorly developed extensions near antennal bases. Pereonites 1–5 anterior margins with stiff simple setae; pereonite 5 with anterolateral margins rounded and blade-like overhang raised above pereonites anterior margin; anterolateral margins of pereonites 6 and 7 with small anteriorly facing lobes.

Paratypes. Antenna 1 of 9 articles; article 1 rectangular, 1.6 times as long as wide, dorsal surface concave, inferior margin with 5 simple setae, mesial surface with 1 broom seta, distal margin with 5 robust setae, 2 flagellate robust setae and 1 broom seta; article 2 0.3 times as long as article 1, 1.8 times as long as wide (not including distal projection) with 2 robust setae, one on distal projection; remaining articles all rectangular; article 4 with 3 simple setae; article 6 with 1 distal aesthetasc; terminal article with 3 small simple setae. Antenna 2 articles 1–3 more or less triangular; article 2 1.1 times as long as article 1, with 1 robust flagellate seta on distosuperior margin and 1 simple seta; article 3 1.4 times as long as article 1, distal margin with 5 peripheral long robust and 1 flagellate robust seta; article 4 small, about half the size of article 3, 1.1 times as long as article 1, not ornamented.

Left and right mandible identical in structure; mandible spine row absent; molar small, terminated by 2 uni-serrate and 3 simple setae (left molar terminated with 4 uni-serrate setae). Maxilla 1 lateral lobe 2.1 times as wide as mesial lobe, lateral and mesial margins with fine simple setae, distal margin with 6 robust, 3 robust dentate and 3 robust semi-plu-

mose setae; mesial lobe with fine simple setae on margins, terminated with 6 simple and 2 long pectinate setae. Maxilla 2 lateral lobe with scattered fine simple setae, distally with 4 long simple setae; middle lobe 1.2 times as wide as lateral lobe, distally with 3 long simple setae; mesial lobe 2.0 times as wide as lateral lobe, margins with fine simple setae, terminated with 7 simple setae, 4 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, small, 0.8 times as long as wide, 0.2 times as long as basis (including endite); basis elongate 2.9 times as long as wide (including endite), with 2 simple setae, distal superior margin with 1 simple seta; endite with 4 coupling hooks, distally with 4 simple setae, 3 fan setae and many fine, simple setae; palp wide proximally distally narrow, article 1 wide, shortest, 2.0 times as long as basal endite, trapezoid, with 2 simple setae on anterolateral margin, anteromesial margin with 1 simple seta; article 2 3.1 times as long as and 1.4 times as wide as article 1, 2.0 times as wide as basal endite, with microtrichs on lateral margin, superior margin with 3 simple setae, lateral face with 1 simple seta, and inferior margin with 3 semi-fan setae and 1 simple seta; article 3 1.7 times as long as wide, and 0.9 times as wide as article 1, superior margin with 2 simple setae, inferior margin with 4 simple setae and 15 semi-fan setae; article 4 rectangular, 0.4 times as long as article 1, superior margin with 1 simple seta, distal margin with 1 simple seta and 3 semi-fan setae; article 5 rectangular, small, narrowest article, 0.8 times as long as, and 0.1 times as wide as article 1, with 5 terminal simple setae; epipod semi-oval, 2.1 times as long as wide, 1.2 times as long as basis, with numerous marginal microtrichs.

Pereopod 1 basis 6.3 times as long as wide, inferior margin with microtrichs and 6 setae (5 SS, 1 distal RFS), lateral face with 2 setae (both SS, distal), superior margin with 3 setae (all SS); ischium 3.5 times as long as wide, inferior margin with 4 setae (all SS), lateral face with 3 setae (2 RFS, 1 SS), superior margin with 5 setae (2 distal SS, 2 short RS, 1 long RS at midpoint); merus 1.2 times as long as wide, inferior margin with 5 setae (all SS), distosuperior margin with 3 setae (all SS); carpus 4.6 times as long as wide, inferior margin with 4 setae (all long SS, 2+2 on proximal half), superior margin with 5 setae (all SS, 2 in distal corner); propodus length 5.3 times as long as wide, inferior margin with 6 setae (all SS), lateral face with 8 setae (all SS, scattered), superior margin with 2 setae (both SS, in proximal half); dactylus 2.3 times as long as proximal width, superior margin with 4 setae (all SS).

Pereopod 5 basis 3.5 times as long as wide, inferior margin with 9 setae (3 RFS & 4 SS all in loose cluster, distal corner with 1 RFS and 1 SS); ischium 2.2 times as long as wide, inferior margin with 10 setae (9 SS, 1 sub-marginal SS); merus 1.2 times as long as wide, inferior margin with 7 setae (all SS); carpus 0.9 times as long as wide, lateral face with 2 setae (both SS), superior margin with 1 seta (RFS, distal corner); propodus slightly expanded, 2.6 times as long as wide, superior margin with 8 setae (7 sub-marginal SS, 1 BS on distal corner); dactylus 5.7 times as long as proximal width, with 4 setae (all SS, on distosuperior margin).

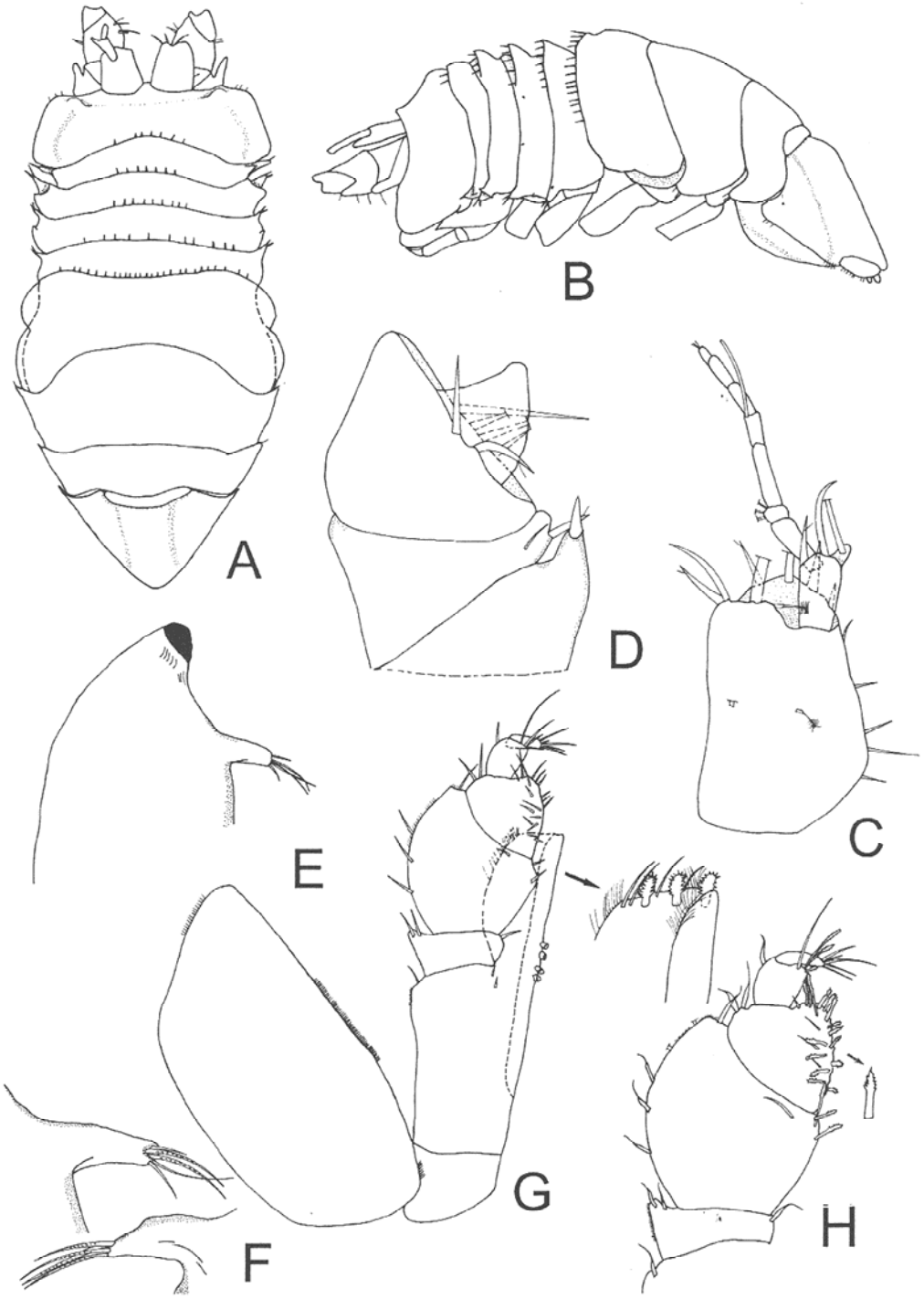

FIGURE 8. *Notopais zealandica* n. sp. A, B, female holotype, 4.5 mm; C–H, female paratype, 4.5 mm. A, dorsal view; B, lateral view; C, left antenna 1; D, right antenna 2; E, right mandible; F, right mandibular molar (top) and left mandibular molar (bottom); G, right maxilliped; H, right maxilliped palp.

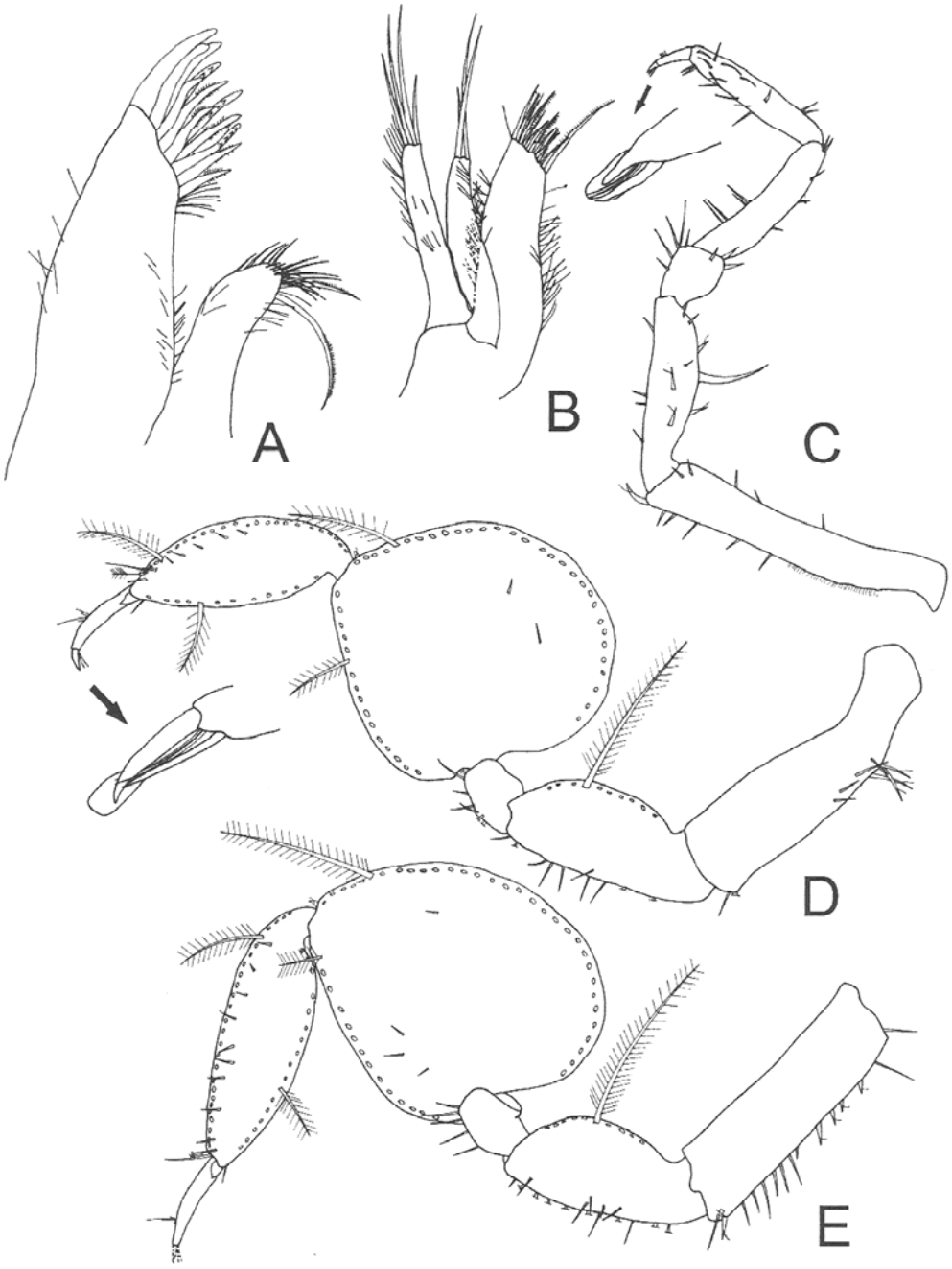

FIGURE 9. *Notopais zealandica* n. sp. A, B female paratype; C–E female holotype. A, right maxilla 1; B, right maxilla 2; C, right pereopod 1; D, left pereopod 5; E, left pereopod 6.

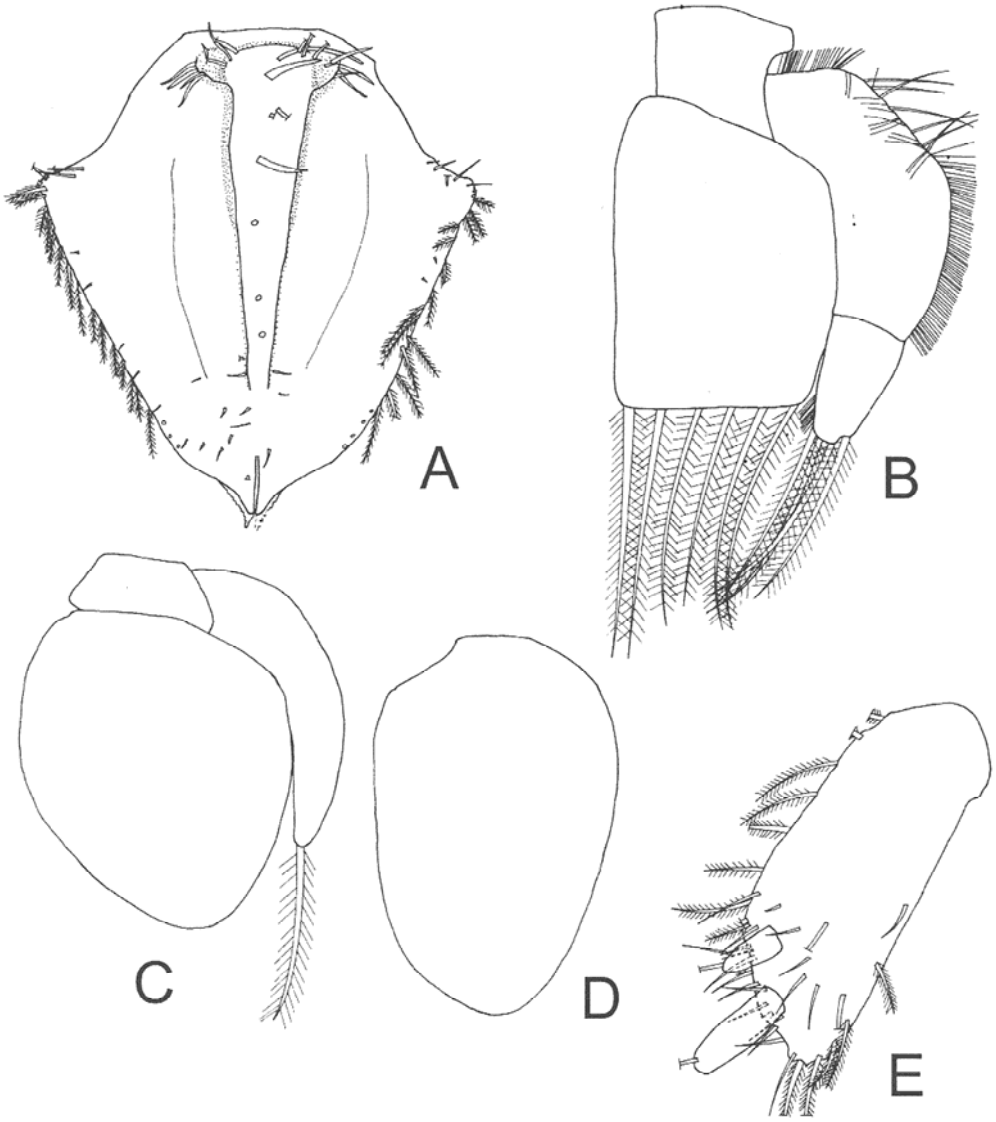

FIGURE 10. *Notopais zealandica* n. sp. All figures from female paratypes, operculum only from female paratype, 3.5 mm. A, operculum; B, left pleopod 3; C, left pleopod 4, D, left pleopod 5; E, left uropod.

Pereopod 6 basis thicker compared with basis in pereopod 5, 3.5 times as long as wide, inferior margin with 16 setae (10 SS, grouped in 2+7+1, 1 sub-marginal distal RS, 5 RFS, grouped in 4+1 on distal margin); ischium similar as in pereopod 5, although 2.1 times as long as wide, inferior margin with 16 setae (11 evenly spaced, marginal SS, 5 sub-marginal SS); merus distosuperior margin cup-shaped, with carpus inserted into it, 1.3 times as long as wide, inferior margin with 5 setae (all SS); carpus similar to carpus of pereopod 5,

except proximal end of superior margin is slightly more expanded, 0.9 times as long as wide, lateral face with 4 setae (all SS); propodus similar although more elongate than in pereopod 5, 2.8 times as long as wide, superior margin with 10 setae (all sub-marginal, evenly spaced SS); dactylus similar to that of pereopod 5, although 6.7 times as long as proximal width; unguis absent.

Pleon 0.5 times as long as proximal width and posterior tip rounded. Operculum large, 2.5 times as long as proximal width, distal end with medial slit and veined lamellar extension, proximal margin of median keel and keel itself provided with robust simple setae (proximal margin 7+8), distal surface with numerous scattered simple setae, anterior margins with 13 simple setae, 6 on right and 7 on left margin, lateral margins with numerous plumose setae. Pleopod 3 exopod distally narrow, 1.3 times as long as endopod, proximo-lateral margin with 6 simple setae set amongst continuous fine simple setae, distally with 4 long plumose setae; endopod 1.4 times as long as wide, with 6 long plumose setae. Pleopod 4 exopod slender, shorter than endopod, with its distal point at 0.7 times endopod length, superior margin smooth, with 1 apical long plumose seta; endopod sub-circular, 1.1 times as long as wide. Pleopod 5 1.5 times as long as wide.

Uropod protopod 2.6 times as long as wide, margins sub-parallel, distomesial angle produced, not extending past endopod, with 1 plumose and 1 simple seta, lateral margin with 8 plumose setae and 11 simple setae, mesial margin with 4 plumose setae, surface with 9 scattered simple setae; exopod small, 0.2 times as long as protopod and 0.6 times as long as endopod, with 3 simple setae; endopod 0.3 times as long as protopod with 1 simple seta.

Remarks: *Notopais zealandica* n. sp. is unique in that all pereonites lack anterior spines on their margins and instead are provided with stiff simple setae, similar to that seen on pereonite 5 of *N. beddardi*. *N. zealandica* is also the only species in this genus without spines on the cephalon, and it has a distinct blade-like extension raised above the anterior margin of pereonite 5.

Distribution: Chatham Rise, New Zealand.

Etymology: *N. zealandica* is named after New Zealand, as this species occurs within its waters.

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The first record of the crustacean isopod genus *Pseudarachna* Sars, 1897 (Isopoda: Asellota: Munnopsidae) from the Southern Hemisphere, with description of a new species from New Zealand

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Abstract

Pseudarachna nohinohi n. sp. from the Challenger Plateau, New Zealand is described. A further two undescribed species are recorded from Australian waters in the Tasman Sea, showing that this formerly monotypic North Atlantic genus is more widely distributed than previously thought. A revised diagnosis of the genus is presented.

Key words: Isopoda, Munnopsidae, *Pseudarachna*, Pacific, taxonomy, Tasman Sea

Introduction

The munnopsid genus *Pseudarachna* was erected by Sars to account for the "anomalous form" (Sars 1897: 142) of the then *Ilyarachna hirsuta* Sars, 1864. The genus has since remained monotypic with a distribution from western Ireland to Denmark (Wolff 1962) and a depth range of 50–478 metres (Svavarsson *et al.* 1993). Material collected from various localities in the Tasman Sea by NIWA, the Australian Museum (Sydney) and by Museum Victoria (Melbourne) has revealed that this genus is present in the Southern Hemisphere.

Material and methods

The holotype and dissected paratypes were used in the preparation of the description and illustrations and are indicated in the figure captions. Specimens were drawn using a Nikon

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Optiphot-2 and a Zeiss Stemi SV 11 dissecting microscope both fitted with a camera lucida. These specimens are derived from material collected by Roger Lincoln while on sabbatical.

Species descriptions were prepared in the computer program DELTA (Dallwitz *et al.* 2000). Unless otherwise stated in text, all ratios were calculated using the maximum lengths and widths of segments.

Abbreviations used in text: AM — Australian Museum, Sydney; NIWA — National Institute for Water and Atmospheric Research, Wellington; NMV — Museum Victoria, Melbourne.

Taxonomy

Munnopsidae Lilljeborg, 1864

Pseudarachna Sars, 1897

Mesostenus Sars, 1864: partim: 9 (preoccupied).
Pseudarachna. — Sars, 1897: 142.— Nierstrasz & Schuurmans-Stekhoven, 1930: 129.— Kussakin, 2003: 261.
Not *Pseudarachna*. — Schultz, 1976: 13.

Type species: *Mesostenus hirsutus* Sars, 1864; by monotypy.

Diagnosis

Cephalic frons enlarged, broad, semi-circular, without defined ridge around antennae; cephalon anterior flanges absent. Pereonites 1–4 not short or compact, dorsal spines present, apical setae present. Pereonite 2 largest; pereonites 5–7, lateral margins not narrow, natasome not reduced. Pleon anterolateral margins rounded, without spine. Antennae positioned widely apart; antenna 1 small, article 1 with lateral flange; antenna 2 article 1 with no anterolateral spine. Mandible lacinia mobilis, spine row and palp all absent; mandibular fossa angular, sub-horizontal across mandible. Pereopod 2 elongate, robust; ischium compact, wider than other articles; pereopods 5 and 6 ischium superior margin with plumose setae; carpus paddle shaped; carpus and propodus with marginal plumose setae; pereopod 7 more ambulatory, with setation similar to that of pereopods 5 and 6; dactyli of natatory pereopods flattened, slightly broadened. Pleopod 4 exopod with more than 1 plumose seta. Pleon triangular, domed in centre. Operculum partially vaulted, with small medial keel. Pleopod 5 simple lobe. Uropods flat, uniramous.

Remarks

Pseudarachna has many unique apomorphies, the most notable being the enlarged, semi-circular shaped cephalic frons, the widely spaced antennae, the small antenna 1,

enlarged pereonite 2 and a robust and enlarged pereopod 2 with a wide, compact ischium. *Pseudarachna* is easily distinguished by these characters from other closely related genera such as *Ilyarachna* Sars, 1870 and *Echinozone* Sars, 1897.

Males are not known for this genus, and thus there is no data specific on sexual dimorphism.

Distribution

In the North Atlantic, from western Ireland to Denmark (Wolff 1962) at depths between 50–478 metres (Svavarsson *et al.* 1993); off eastern Australia at approximately 36° south and, Bass Strait at 38° south off Point Hicks (both records of undescribed mancas) at depths between 960–1277 metres; and the Challenger Plateau, west of the South Island, New Zealand at depths between 1005–1463 metres.

***Pseudarachna nohinohi* n. sp.**
(Figs 1–3)

Material examined — All Challenger Plateau, Tasman Sea, New Zealand. **Holotype**. Ovigerous female (1.7 mm), stn P929, 40°42.8'S 167°56.0'E, 18 April 1980, epibenthic sled, 1029 m, RV *Tangaroa* (NIWA 23787). **Paratypes**. 2 females (2 mm [dissected], 2 mm), 1 fragment, stn P941, 41°15.2'S 167°07.2'E, 23 April 1980, epibenthic sled, 1463–1457 m, RV *Tangaroa* (NIWA 23788); 2 females (1.7 mm [dissected], 2 mm [dissected]), stn P927, 40°50.1'S 168°14.8'E, 18 April 1980, epibenthic sled, 1009–1005 m, RV *Tangaroa* (NIWA 23789).

Description Holotype

Body about 2.1 times as long as greatest width of pereonite 2; widest at pereonite 2; cuticle not highly calcified, lightly setose. Cephalon covered with many long setae, spines absent; posterolateral margins rounded. Pereonites 1–4 each with pair of anterior submarginal short spines. Pereonite 5 anterior margin smooth, anterolaterally square; anterolateral margins of pereonites 2–4 with pair of small spines, 6–7 rounded. Pereonite 7 ventrally with no ornamentation. Pleon as long as proximal width, dorsal surface sculptured, with rounded medial keel, posterior tip rounded, with scattered simple setae.

Paratypes

Antenna 1 of 7 articles; article 1 lateral flange reaching beyond article 2, 1.6 times as long as wide, lateral margin with 2 penicillate setae (on lateral flange), distal margin with 1 penicillate seta and 1 elongate sensillate robust seta; article 2 rectangular, 0.4 times as long article 1 and 2.2 times as long as wide, with 4 distal penicillate setae; article 6 with 1 distal aesthetasc; terminal article with 2 simple setae and distal aesthetasc. *Antenna 2* damaged; article 1 margins smooth; article 2 2.0 times as long as article 1, with 1 sensillate robust

seta and 1 simple seta; article 3 2.8 times as long as article 1, with 2 sensillate robust setae and 1 simple seta; article 4 elongate, 3.3 times as long as article 1, with no ornamentation; article 5 19.5 times as long as article 1, mesial margin with 12 sensillate robust setae, surface with 3 simple setae, lateral margin with 5 simple setae and 11 sensillate robust setae.

Mandible molar small, distally with 3 simple setae (on right molar, none on left). *Maxilla 1* lateral and mesial margins with fine simple setae; lateral lobe 2.1 times as wide as mesial lobe, distal margin with few fine simple setae, 5 robust setae, 3 dentate robust setae and 4 pectinate robust setae; mesial lobe terminated with 5 simple setae and 2 long pectinate setae. *Maxilla 2* lateral lobe margins with fine simple setae, distally with 4 long pectinate setae; middle lobe 1.1 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.1 times as wide as lateral lobe, margins with fine simple setae, proximally, mesial margin with 3 elongate, lightly plumose setae, distally with 3 blunt simple setae, few fine simple setae, 1 toothed seta and 1 long pectinate seta. *Maxilliped* coxa rectangular, 1.1 times as long as wide and 0.5 times as long as basis (including endite); basis elongate, 2.4 times as long as wide (including endite); endite with 1 coupling hook (on right maxilliped, 2 on left), distally with 2 toothed setae, 5 fan setae and many fine simple setae; palp article 1 rectangular, 0.3 times as long as basal endite, cuticular scales present, with 1 simple seta each on distolateral and distomesial margin; article 2 3.7 times as long as and 1.3 as wide as article 1, 1.2 times as wide as basal endite, lateral margin with cuticular scales and 2 simple setae, mesial margin with 3 distally pappose setae and 1 simple seta; article 3 1.8 times as long as and 1.0 times as wide as article 1, lateral margin with 1 simple seta, mesial margin with 1 simple seta and 5 distally pappose setae; article 4 1.4 times as long as and 0.5 times as wide as article 1, distal margin with 3 simple setae (left maxilliped palp article 4 with 4 simple setae); article 5 with 4 terminal simple setae; left maxilliped palp article 5 0.8 times as long as and 0.5 times as wide as article 4, with 3 simple setae; epipod 2.2 times as long as wide, 1.4 times as long as basis, margins with many cuticular scales and 1 simple seta.

Pereopod 1 basis 6.0 times as long as wide, inferior margin with 2 weakly plumose setae, 4 simple setae (3 long) and 1 distal sensillate robust seta, superior margin with 2 simple setae, 1 penicillate seta and 1 long sensillate robust seta; ischium 6.8 times as long as wide, inferior margin with 2 simple setae, superior margin with 2 simple setae and 2 sensillate robust setae; merus 2.2 times as long as wide, inferior margin with 3 simple setae, distosuperior margin with 1 small simple seta; carpus 10.0 times as long as wide, inferior margin with 2 small simple setae, in proximal half; propodus 15.0 times as long as wide, distoinferior margin with 5 simple setae, distosuperior margin with 2 simple setae; dactylus 4.9 times as long as proximal width, superior margin with 3 small simple setae.

Pereopod 2 basis 4.1 times as long as wide, inferior margin with 9 simple setae, superior margin with 5 simple setae and 1 penicillate seta; ischium 1.2 times as long as wide, inferior margin with 2 sensillate robust setae and 1 simple seta, distally with 14

sensillate robust setae (8 on mesial side and 6 on lateral side), mesial surface with 4 simple setae (1 simple seta on lateral surface), superior margin with 2 simple setae and 1 sensillate robust seta; merus 1.4 times as long as wide, distoinferior margin with 4 sensillate robust setae, distosuperior margin with 2 simple setae; carpus 4.1 times as long as wide, inferior margin with 1 simple seta and 7 long sensillate robust setae, mesial surface with 1 penicillate seta and 3 simple setae, lateral surface with 10 sensillate robust setae, superior margin with 4 simple setae; propodus 3.8 times as long as wide, inferior margin with 4 sensillate robust setae, lateral surface with 3 sensillate robust setae, distosuperior margin with 1 sensillate robust seta and 1 simple seta; dactylus 5.2 times as long as proximal width, with 2 robust simple setae and 5 simple setae.

Pereopod 5 basis 4.8 times as long as wide, inferior margin with 9 simple setae, lateral surface with 1 penicillate seta, superior margin with 2 penicillate setae and 3 simple setae; ischium 2.9 times as long as wide, inferior margin with 8 simple setae; merus as long as wide, inferior margin with 2 simple setae, distosuperior margin with 1 simple seta and 1 small plumose seta; carpus 1.3 times as long as wide, distosuperior corner with 2 simple setae; propodus 2.8 times as long as wide, lateral surface with 1 simple seta, distosuperior corner with 1 simple seta; dactylus 4.0 times as long as proximal width, distosuperior margin with 1 simple seta.

Pereopod 6 basis 6.1 times as long as wide, inferior margin with 3 sparsely plumose setae and 3 simple setae, lateral surface with 1 sparsely plumose seta, 2 penicillate setae, mesial surface with 1 long simple seta, superior margin with 1 simple seta and 1 penicillate seta; ischium 3.3 times as long as wide, inferior margin with 5 simple setae, mesial surface with 2 simple setae; merus 1.5 times as long as wide, inferior margin with 5 simple setae, distosuperior margin with 2 simple setae; carpus 2.1 times as long as wide, lateral surface with 1 simple seta; propodus 3.5 times as long as wide, inferior margin also with 1 distal simple seta, superior margin with 1 distal simple seta and with 4 scale-like structures; dactylus 6.4 times as long as proximal width, distosuperior margin with 4 simple setae.

Pereopod 7 basis 5.0 times as long as wide, inferior margin with 3 plumose setae and 2 simple setae, lateral surface with 2 simple setae, superior margin with 3 penicillate setae; ischium 3.9 times as long as wide, inferior margin with 4 simple setae, lateral surface with 1 simple seta; merus 1.8 times as long as wide, inferior margin with 4 simple setae, distosuperior margin with 1 simple seta; carpus 3.1 times as long as wide, mesial surface with 1 simple seta; propodus 11.0 times as long as wide, distoinferior corner with 1 simple seta, superior margin with 6 sub-marginal simple setae and scale-like structures in proximal half, plumose setae absent; dactylus 7.0 times as long as proximal width, distosuperior margin with 5 simple setae.

Operculum 2.1 times as long as proximal width, median keel wide, somewhat flattened with long lightly plumose setae on both sides, surface with numerous lightly plumose setae, distally with pair of simple setae, 8 heavily plumose setae, medial excision and veined lamellar extension. *Pleopod 3* exopod 1.4 times length of endopod, distally

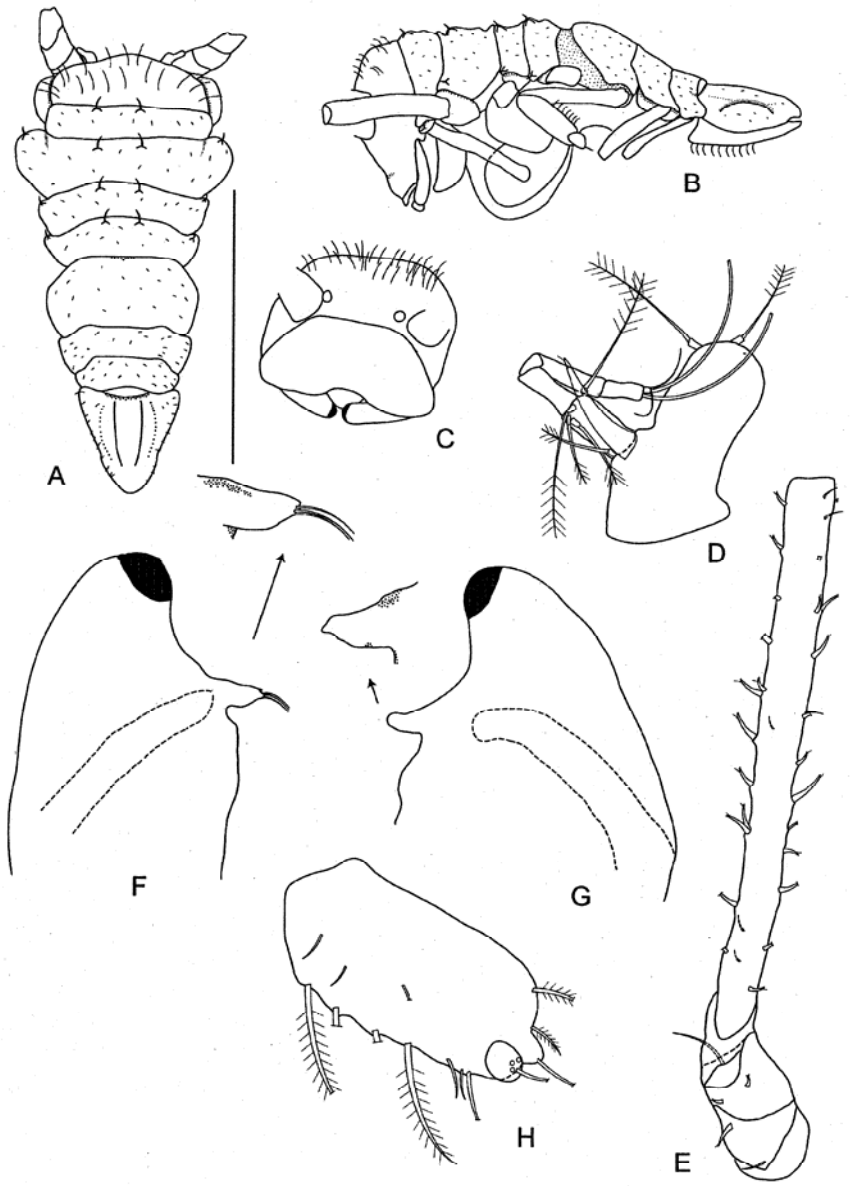

FIGURE 1. *Pseudarachna nohinohi* n. sp. A–C, female holotype, 1.7 mm (NIWA 23787); D, E, female paratype, 2 mm (NIWA 23788); F–H, female paratype, 1.7 mm (NIWA 23789). A, dorsal view; B, lateral view; C, cephalon; D, right antenna 1; E, right antenna 2; F, right mandible; G, left mandible; H, left uropod. Scale bar = 1 mm, for dorsal and lateral view only.

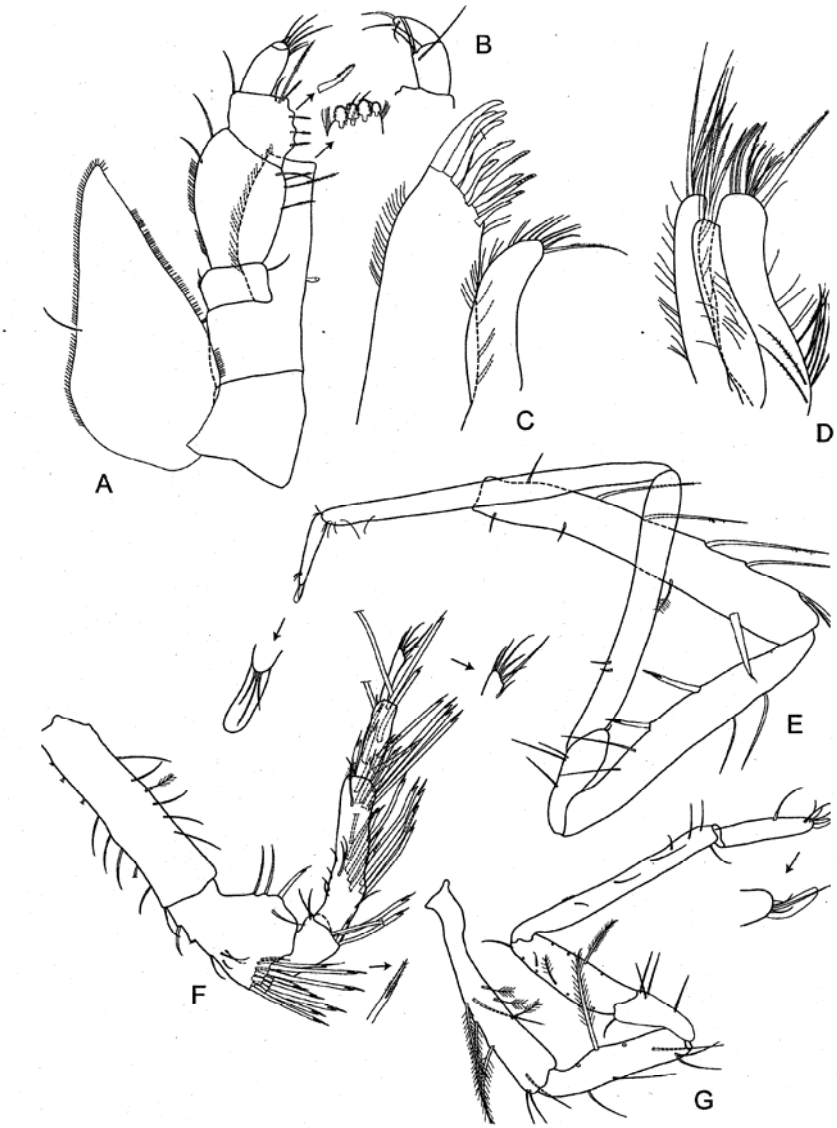

FIGURE 2. *Pseudarachna nohinohi* n. sp. A–D, F, female paratype, 2 mm (NIWA 23788); E, G, female paratype, 1.7 mm (NIWA 23789). A, right maxilliped; B, left maxilliped palp, articles 4 and 5; C, right maxilla 1; D, right maxilla 2; E, left pereopod 1; F, left pereopod 2; G, left pereopod 7.

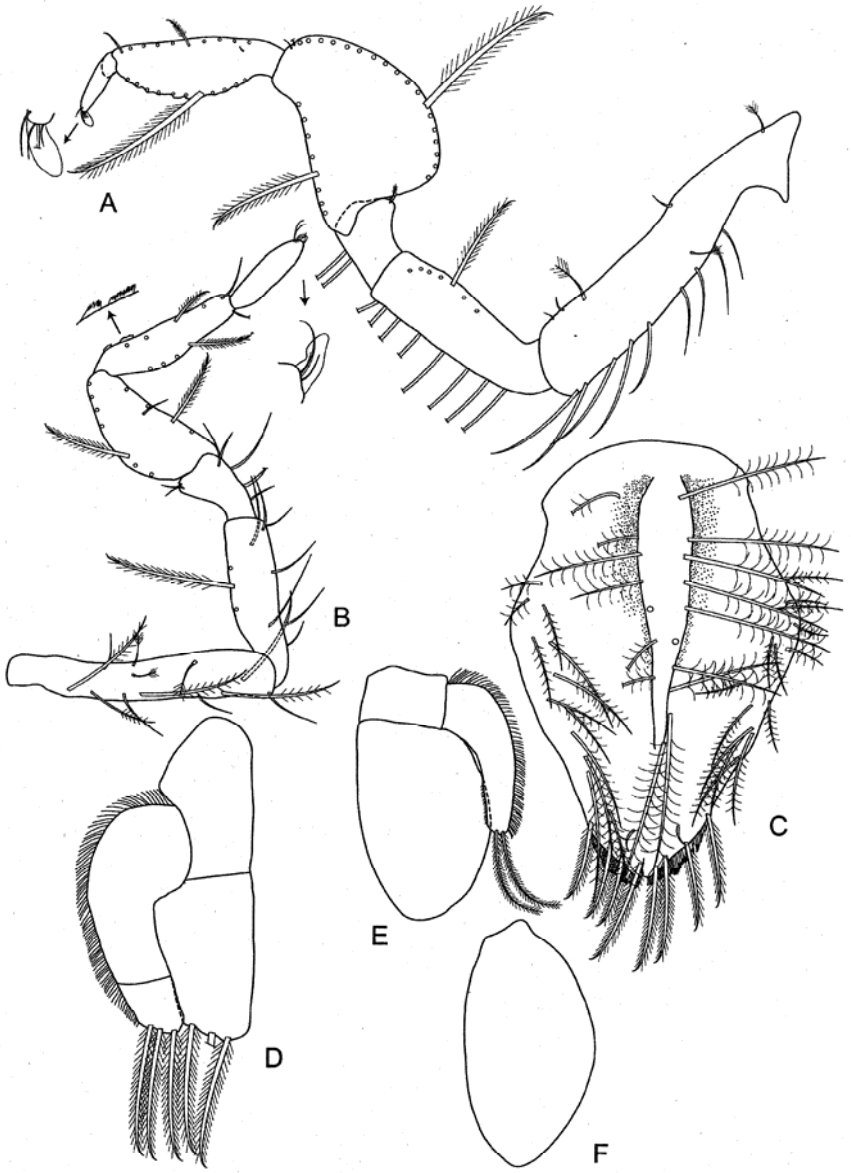

FIGURE 3. *Pseudarachna nohinohi* n. sp. A, female paratype, 2 mm (NIWA 23789); B, female paratype, 1.7 mm (NIWA 23789); C–F, female paratype, 2 mm (NIWA 23788). A, right pereopod 5; B, left pereopod 6; C, operculum; D, right pleopod 3; E, left pleopod 4; F, left pleopod 5.

with 3 long plumose setae; endopod 1.7 times as long as wide, with 3 long plumose setae. *Pleopod 4* exopod distally with 2 long plumose setae; endopod oval, 1.5 times as long as wide. *Pleopod 5* 1.9 times as long as wide.

Uropod protopod 2.2 times as long as wide, oval, distal bulb with 1 simple seta, lateral margin with 4 plumose setae and 3 simple setae, distal margin with 2 plumose setae and surface with 3 simple setae; endopod 0.1 times as long as protopod, with at least 1 simple seta (3 sockets also present).

Remarks

Pseudarachna nohinohi n. sp. can be distinguished from the only other species in this genus, *P. hirsuta*, by the carpus and propodus of pereopod 2 being more setose in *P. nohinohi* than in *P. hirsuta*; the lateral flange of antenna 1 article 1 is round (square in *P. hirsuta*) and reaches beyond article 2 (does not reach beyond article 2); and the uropod is less elongate (2.1 times as long as wide versus 2.8 times as long as wide in *P. hirsuta*), is less setose on margins and has a distal bulb (absent).

Distribution

Known from the Challenger Plateau, Tasman Sea, off the west coast of New Zealand; at depths between 1029–1463 m.

Etymology

Nohinohi is a Māori word meaning little or small; noun in apposition.

***Pseudarachna* spp.**

Manca (1.7 mm), Tasman Sea, off eastern Australia, 36°57.95'S 150°22.0'E, 960–1050 m, P. A. Hutchings, 12 December 1986, RV *Franklin*, thick grey mud with hard clay lumps (AM P62620). Manca (1.2 mm), stn SLOPE 67, 67 km south of Point Hicks, from 38°23.95–78'S 149°17.02–15.24'E, 1277–1119 m, G. C. B. Poore *et al.*, 25 October 1988, RV *Franklin*, fine mud (NMV J18885).

Remarks

Although these species, both distinct, are not described, these records provide additional distribution data for the genus, indicating that at least three species occur in the south-western Pacific region.

Acknowledgements

I would like to thank: NIWA for their support and the use of their facilities; the University of Canterbury for funding provided through a PhD scholarship; Penny Berents (AM) and

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Jo Taylor (NMV) for the loan of material; and Niel Bruce (NIWA) and the anonymous reviewers whose comments improved this manuscript.

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Two new species of the deep-water asellotan genus *Notopais* Hodgson, 1910 (Crustacea: Isopoda: Munnopsidae) from the south-western Pacific

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Abstract: Two new species of *Notopais* are described, *Notopais echinatus* sp. nov. from the continental slope of eastern Australia, at a depth of 2400-2500 metres, and *Notopais euaxos* sp. nov. from the Chatham Rise off the eastern coast of South Island, New Zealand, from depths of 2476-2542, the greatest recorded depths for the genus.

Résumé: *Deux nouvelles espèces profondes d'isopodes asellotes du genre* Notopais *Hodgson, 1910 (Crustacea: Isopoda: Munnopsidae) du Sud-Ouest de l'Océan Pacifique.* Deux nouvelles espèces du genre *Notopais* sont décrites, *Notopais echinatus* sp. nov. Du talus continental à l'est de l'Australie, à une profondeur de 2400-2500 mètres, et *Notopais euaxos* sp. nov. de la Ride Chatham au large de la côte est de l'Ile du Sud, Nouvelle Zélande, à une profondeur de 2476-2542 mètres, les plus grandes profocdeurs connues pour le genre.

Keywords: *Notopais*, Munnopsidae, Taxonomy, Pacific, Deep sea, Australia, New Zealand, Crustacea

Introduction

The munnopsid genus *Notopais* Hodgson, 1910, one of six genera in the sub-family Ilyarachninae Hansen, 1916, has been most recently reviewed by Merrin (2004). *Notopais* has an exclusive Southern Hemisphere distribution, to a depth of 2600 metres, and is currently composed of seven species – five from the waters around Antarctica and one each from off south-eastern Australia and New Zealand (Merrin, 2004).

This paper describes a further two new species of *Notopais*, one from the continental slope of eastern Australia and the other from the Chatham Rise to the east of New Zealand's South Island. For methods refer to Merrin (2004).

Abbreviations: PS – penicillate seta/ae; SRS –sensillate robust seta/ae; RS – robust seta/ae; SS – simple seta/ae; AM – Australian Museum, Sydney; NIWA – National Institute for Water and Atmospheric Research, Wellington.

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Appendix: D

Taxonomy

Family MUNNOPSIDAE Lilljeborg, 1864
Subfamily Ilyarachninae Hansen, 1916

Notopais Hodgson, 1910

Notopais Hodgson, 1910: 69.— Merrin, 2004: 3–4.

Remarks

Merrin (2004) presented a revised generic diagnosis to the genus. Both *N. echinatus* sp. nov. and *N. euaxos* sp. nov. are found at depths between 2400 and 2600 metres, the greatest depth known for this genus, and a depth extension of a little less than 1 kilometre (*N. zealandica* Merrin, 2004 had been recorded from 1640 metres).

Notopais echinatus sp. nov.
(Figs 1 & 3)

Material examined

Holotype. Female (two halves together, 8.5 mm), stn FR1086-4, continental slope of eastern Australia, east of Flinders Island, Tasman Sea, 40°45.94–46.54'S, 149°01.62–00.27'E'E , 2400–2500 m, 10 December 1986, clay, thick mud, light grey colour, some rock (siltstone) (AM P.72860). Paratypes. 3 female, (8.0 mm [two halves together, dissected], 6.0 mm [dissected]) 2 male (7.0 mm [two halves together, dissected]), 4 fragments, type locality (AM P.62613).

Description

Female. Body about 2.5 times as long as greatest width (from spine tip to spine tip) of pereonite 2; pereonites 2 and 3 width sub-equal, widest; cuticle calcified, with many tubercles. Cephalon with 2 large and 4 small spines; lateral margins with several small spines; posterolateral margins sub-rectangular. Pereonites 1–4 with numerous tubercles; anterior margins each with 4 well-developed sub-marginal spines, laterally each with pair of marginal spines, pereonite 4 with additional pair of lateral spines; pereonites 5–7 dorsally with many pairs of spines and tubercles; pereonite 5 anterior margin with 2 pairs of widely spaced spines, anterolateral margin twice indented; pereonite 6 with small anterolateral lobes, ventrally with 6 scattered setae; pereonite 7 anterolateral margins rounded, ventrally with row of setae. Pleonite 1 with 1 pair of spines. Pleon as long as proximal width, posterior tip rounded, dorsally with several pairs of tubercles.

Antenna 1 of 9 articles; article 1 elongate, distal ends rounded, 1.7 times as long as wide, mesial margin with 3 SRS (2 long, 1 short), surface with 2 PS and 1 RS, lateral margin with 8 SRS, distal margin with 3 PS and 1 SRS; article 2 0.3 times as long article 1, 1.8 times as long as wide, with 1 mesial SS, distally with 2 RS and 1 PS; article 5 with 1 SS; from article 7, each article has an aesthetasc; terminal article also with 1 PS and 1 SS.

Mandible lacinia mobilis and spine row absent; molar small, with 5 uni-serrate setae. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 2.1 times as wide as mesial lobe, distal margin with few fine SS, 3 RS, 1 dentate RS, 2 dentate pectinate RS and 6 pectinate RS; mesial lobe distally with 8 SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 2.0 times as wide as lateral lobe, margins and surface with fine SS, distally with 6 SS, 7 toothed setae and 1 long pectinate seta. Maxilliped coxa rectangular, 1.2 times as long as wide, 0.3 times as long as basis (including endite); basis elongate, 2.4 times as long as wide (including endite), distolateral margin with 1 SS; endite with 5 coupling hooks, distally with 6 blunter SS, 8 fan setae (distomesial one longest) and many fine SS; palp article 1 wide, shortest, rectangular, 0.3 times as long as basal endite, distolateral margin with 1 SS, distomesial margin with 1 SS; article 2 3.9 times as long as and 1.2 as wide as article 1, 1.6 times as wide as basal endite, lateral margin with 7 SS and cuticular scales, mesial margin with 6 distally pappose setae (of varying lengths); article 3 1.9 times as long as and 0.8 times as wide as article 1, mesial margin with 1 long SS and 16 distally pappose setae (2 sub-marginal); article 4 rectangular, with distomesial bulge, 1.1 times as long and 0.4 times as wide as article 1, lateral margin with 2 SS, distomesial margin with 4 SS and 4 distally pappose setae; article 5 small, rectangular, narrow, 0.9 times as long as and 0.1 times as wide as article 1, lateral margin with 1 SS, distally with 5 SS; epipod 1.8 times as long as wide, and as long as basis, lateral margin with fine SS and few scattered SS.

Pereopod 1 basis 4.5 times as long as wide, inferior margin with 4 SS and 1 distal SRS, superior margin with 1 SS and 1 SRS; ischium 5.0 times as long as wide, inferior margin with 3 evenly spaced SS, mesial surface with 3 SS, superior margin with 2 SRS and 1 distal SS; merus 1.1 times as long as wide, inferior margin with 2 marginal SRS and 3 RS, mesial surface with 2 SRS, distosuperior margin with 3 SS; carpus 5.9 times as long as wide, inferior margin with 3 SS (in proximal half), superior margin with 3 evenly spaced SS; propodus 7.7 times as long as wide, inferior margin with 8 SS (all in distal half, 5 sub-marginal), mesial surface with 2 SS, superior margin with 3 distal SS; dactylus 2.6 times as long as proximal width, superior margin with 2 SS.

Pereopod 2 basis 4.2 times as long as wide, inferior margin with 3 SRS, superior margin with 3 SRS (1 on dis-

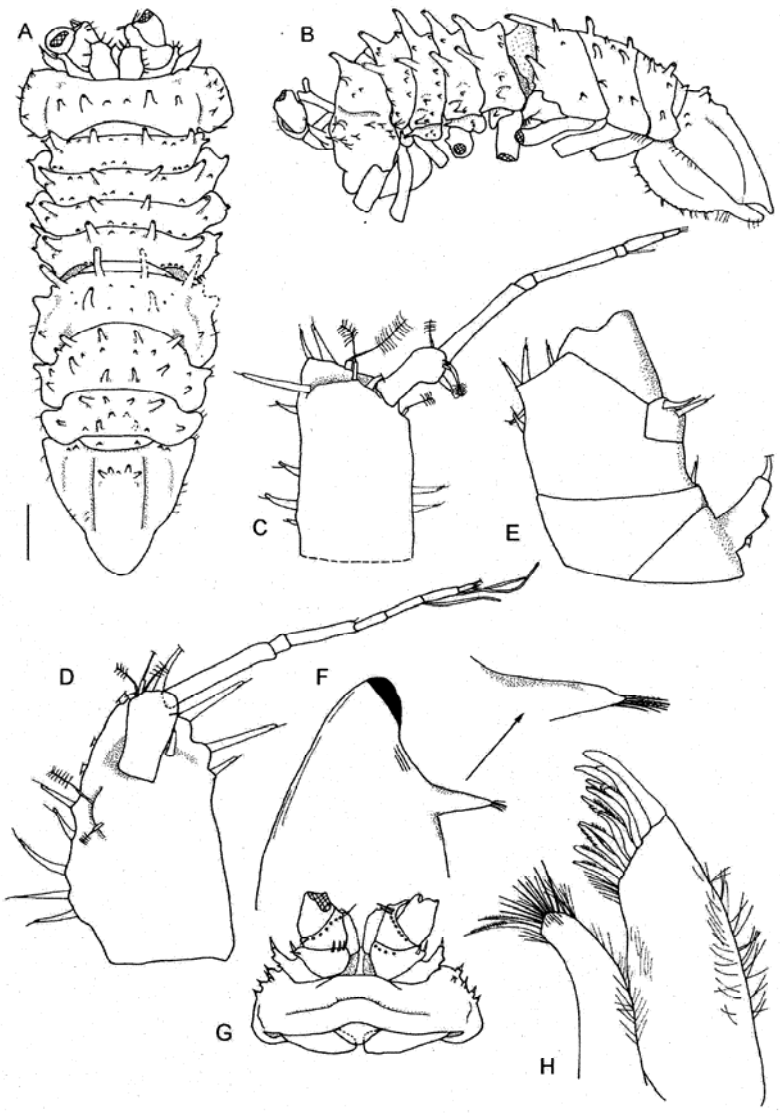

Figure 1. *Notopais echinatus* sp. nov. **A, B & G.** Female holotype (8.5 mm; AM P.72860). **D, F & H.** Female paratype (8.0 mm; AM P.62613). **C & E.** Male paratype (7.0 mm; AM P.62613). **A.** Dorsal view. **B.** Lateral view. **C.** Right antenna 1. **D.** Left antenna 1. **E.** Right antenna 2. **F.** Right mandible. **G.** Ventral view of cephalon. **H.** Left maxilla 1. Scale bar = 1 mm, for dorsal and lateral views only.

Figure 1. *Notopais echinatus* sp. nov. **A, B & G.** holotype femelle (8.5 mm; AM P.72860), **D, F & H.** paratype femelle (8.0 mm; AM P.62613), **C & E.** paratype mâle (7.0 mm; AM P.62613). **A.** vue dorsale ; **B.** vue latérale ; **C.** antennule droite ; **D.** antennule gauche ; **E.** antenne droite ; **F.** mandibule droite ; **G.** cephalon, vue ventral ; **H.** maxillule gauche. Échelle = 1 mm, vue dorsale et latérale.

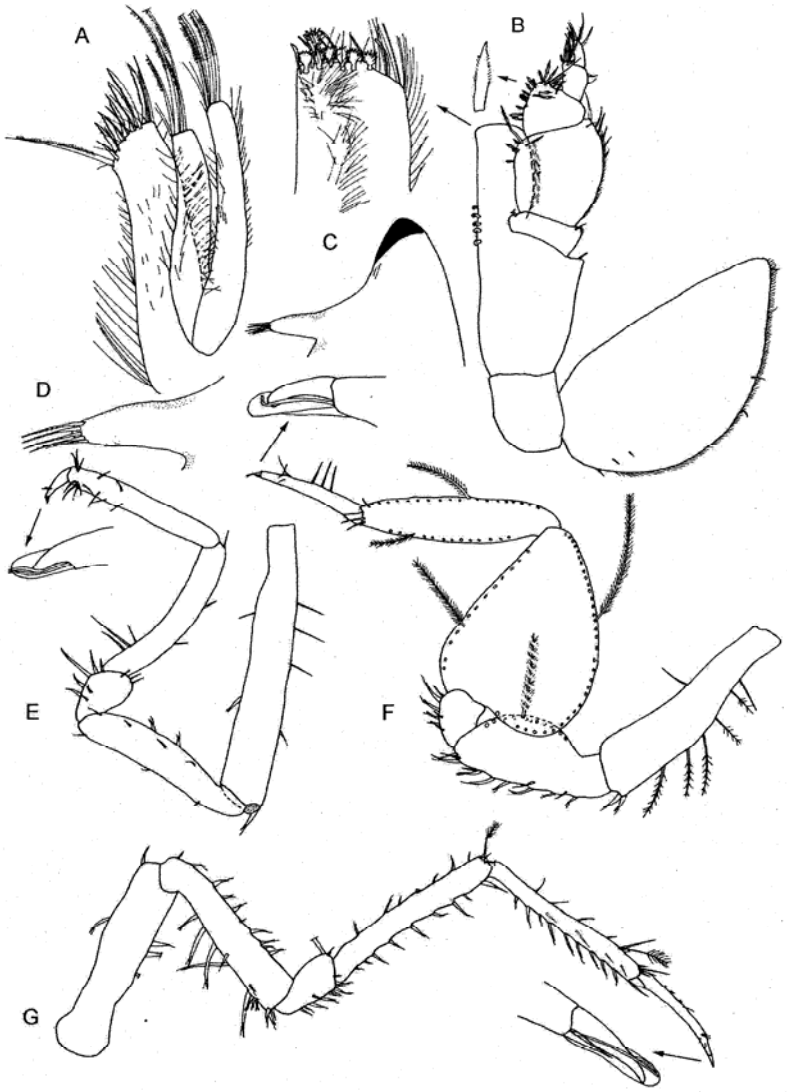

Figure 2. *Notopais echinatus* sp. nov. **A–D.** female paratype, **E–G.** from second female paratype only (6.0 mm; AM P.62613). **A.** left maxilla 2; **B.** left maxilliped; **C.** left mandible; **D.** left mandibular molar; **E.** right pereopod 1; **F.** left pereopod 6; **G.** left pereopod 2.

Figure 2. *Notopais echinatus* sp. nov. **A–D.** paratype femelle, **E–G.** du second paratype femelle seul (6.0 mm; AM P.62613). **A.** maxille gauche ; **B.** maxillipède gauche ; **C.** mandibule gauche ; **D.** mandibule molaire gauche ; **E.** péréiopode 1 droite ; **F.** péréiopode 6 gauche ; **G.** péréiopode 2 gauche.

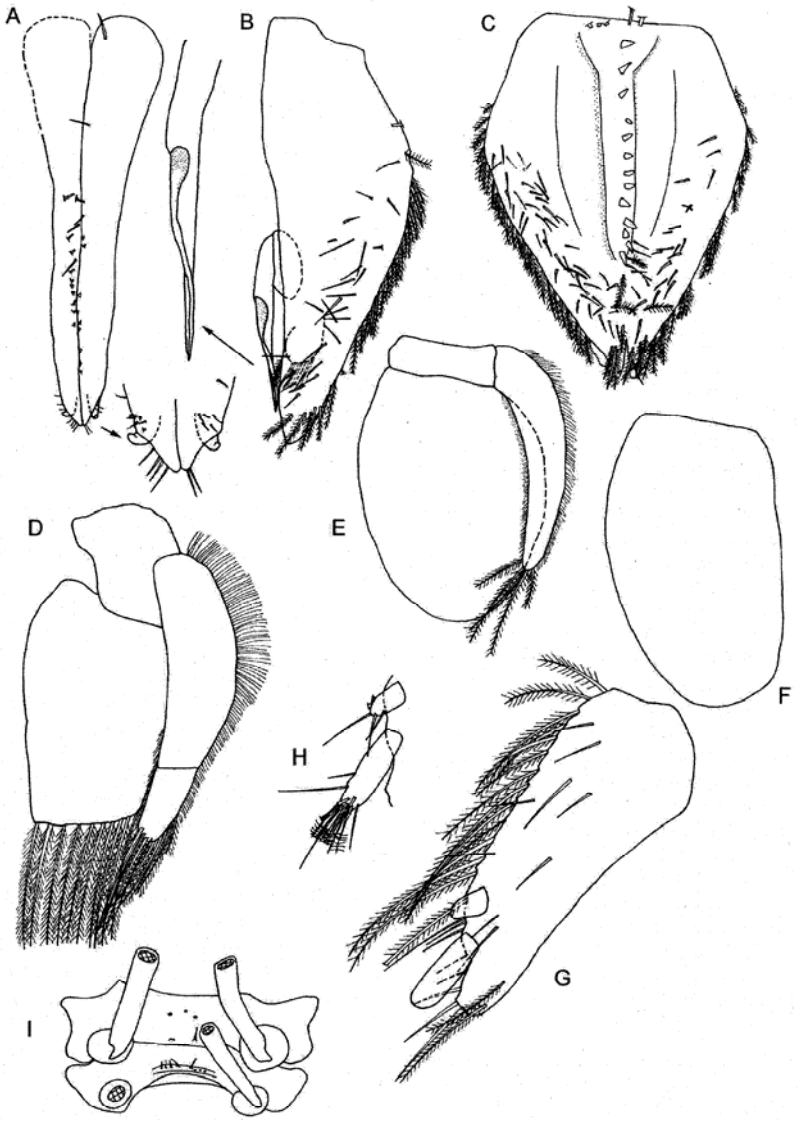

Figure 3. *Notopais echinatus* sp. nov. **A & B.** male paratype, **C–H.** female paratype, **I.** female holotype. **A.** pleopod 1; **B.** left pleopod 2; **C.** operculum; **D.** left pleopod 3; **E.** left pleopod 4; **F.** right pleopod 5; **G.** left uropod; **H.** endopod and exopod of left uropod; **I.** ventral view of pereonites 6 and 7.

Figure 3. *Notopais echinatus* sp. nov. **A & B.** paratype mâle, **C–H.** paratype femelle, **I.** holotype femelle. **A.** pléopode 1 ; **B.** pléopode 2 gauche ; **C.** opercule ; **D.** pléopode 3 gauche ; **E.** pléopode 4 gauche ; **F.** pléopode 5 droite ; **G.** uropode gauche ; **H.** enodopodite et exopodite de l'uropode gauche ; **I.** péréionites 6 et 7 vue ventrale.

Appendix: D

tal margin); ischium 4.6 times as long as wide, inferior margin with 13 SRS (of varying lengths, 2 sub-marginal), superior margin with 9 SRS and 1 proximal SS; merus 1.7 times as long as wide, inferior margin with 9 SRS, mesial surface with 2 SRS, distosuperior margin with 2 SRS (1 long and 1 short); carpus 7.9 times as long as wide, inferior margin with 9 SRS (lengths varying), superior margin with 6 SRS, 4 SS and 1 PS (all evenly spaced except for 2 SRS, 1 SS and 1 PS on distosuperior margin); propodus 10.2 times as long as wide, inferior margin with 9 SRS and 1 distal SS, mesial surface with 4 SS, superior margin with 4 evenly spaced SS and 2 small sub-marginal SS, distally with 1 long SS, 1 PS and a clump of 4 SS; dactylus 6.9 times as long as proximal width, superior margin with 9 small SS and mesial surface with 5 SS.

Pereopod 6 basis 4.1 times as long as wide, inferior margin with 1 proximal SS, 5 plumose setae and 2 distal SRS, superior margin with 1 SS (at mid-point); ischium 2.2 times as long as wide, inferior margin with 7 long SRS and 5 SS (4 SS are sub-marginal); merus 1.1 times as long as wide, inferior margin with 4 long SRS and 3 sub-marginal SS; carpus 1.2 times as long as wide; propodus 4.2 times as long as wide, inferior margin with 2 distal SS, superior margin with 1 distal SS; dactylus 5.8 times as long as proximal width, with 7 SS.

Operculum 2.1 times as long as proximal width, median keel provided with row of RS and few RS proximally, surface with scattered SS, distally with 11 plumose setae (6 of these in a row, 3 each side of medial split), medial excision and veined lamellar extension, lateral margins with numerous plumose setae. Pleopod 3 exopod 1.2 times length of endopod, with row of fine SS, distally with 10 long plumose setae; endopod 1.7 times as long as wide, with 10 long plumose setae. Pleopod 4 exopod distally with 5 long plumose setae; endopod oval, 1.4 times as long as wide. Pleopod 5 1.6 times as long as wide.

Uropod protopod 2.5 times as long as wide, lateral margin with 4 SS and 14 plumose setae, surface with 9 scattered SS, distomesial angle produced, not extending past endopod, provided with 4 SS and 2 plumose setae; exopod small, 0.1 times as long as protopod, 0.5 times as long as endopod, with 5 SS; endopod 0.2 times as long as protopod, with 5 SS and 7 PS.

Male. Antenna 1 with 8 articles; article 1 and 2 ratios similar to female; article 1 mesial margin with 5 SRS, distal margin with 3 SRS and 2 PS, lateral margin with 2 SRS and 1 PS; article 2 2.3 times as long as wide, distal margin with 2 SRS and 3 PS; article 6 with 1 aesthetasc. Antenna 2 damaged; article 1 lateral margin with 2 SRS; article 2 1.1 times as long as article 1, distolateral margin with 1 SRS; article 3 1.9 times as long as article 1, scale with 2 SRS, distomesial margin with 5 SRS; article 4 small, 1.3 times as long as article 1, with no ornamentation.

Pleopod 1 about 3.3 times as long as proximal width, lateral margins indented 0.5 from proximal end, with 24 SS (13+11) on either side of centre margin, distally with 20 SS (8+12). Pleopod 2 protopod 3.1 times as long as wide, lateral margin with row of plumose setae, surface with 29 SS, distal margin with 4 plumose setae (all sub-marginal), mesial margin with 4 plumose setae; exopod 0.1 times as long as protopod, with fines SS; stylet 0.5 times as long as protopod, not hooking up into proximal part of protopod, terminating to a point; sperm duct 0.6 times as long as stylet.

Remarks

Notopais echinatus sp. nov. is most similar to *Notopais euaxos* sp. nov., both species differing from all others in the genus in being highly ornamented, with numerous dorsal pereonal spines and tubercles. In dorsal view, *N. echinatus* differs from *N. euaxos* by having larger spines on the anterior margins of pereonites 1–4; fewer tubercles on the posterior margin of pereonites 1–4; pereonite 5 anterior margin with four evenly spaced spines as opposed to a pair of widely space spines; more large spines on pereonites 5–7; and a different patterning of spines and tubercles on the pleon. Other differences between the two species include: *N. echinatus* antenna 2 article 1 with fewer robust setae and article 3 distolateral margin only having two sensillate robust setae, while in the same position in *N. euaxos* is a small rounded distolateral angle with five robust setae; pereopod 1 of *N. echinatus* has fewer setae than its counterpart, especially on the inferior margins of the merus and carpus; and the operculum of *N. echinatus* has numerous plumose setae and simple setae between the end of the keel and the distal margin, while in *N. euaxos* there are no setae in this area, with just a few long plumose setae at the distal end of the medial keel.

The unguis, which has been illustrated for the respective pereopods of both *N. echinatus* and *N. euaxos*, differs to that illustrated for *Notopais minya* Merrin, 2004 and *N. zealandica* (see Merrin 2004). All pereopodal ungui in both *N. minya* and *N. zealandica* have been illustrated with two sensillae and these sensillae are pointed. Closer examination has shown that the sensillae more blunt than originally thought and that the unguis has two sensillae in pereopods 1 and 2 (pereopods 3 and 4 remain unknown for the genus) and only one sensilla for pereopods 5–7 (pers. obs.). Re-examination of the type material for *N. minya* and *N. zealandica* shows the structure of the unguis to be the same as that described here.

Distribution

Known only from the type locality, east of Flinders Island, Tasman Sea, Australia, between the depths of 2400–2500 metres.

Etymology

From the Latin *echinatus* (= spiny or prickly); in reference to the dorsal spines and tubercles.

Notopais euaxos sp. nov.
(Figs 4 & 5)

Material examined

Holotype. Female (9.0 mm), Chatham Rise, South Island, New Zealand, stn S202, 42°14.77–16.6'S, 175°8.6–10.6'E, epibenthic sled, 2476–2542 m, 2 November 1979, R.V. *Tangaroa* (NIWA 23786). Paratype. Female (12.5 mm), same data as holotype, (NIWA 23785).

Description

Body about 2.7 times as long as greatest width (from spine tip to spine tip) of pereonite 2; pereonites 2 and 3 width sub-equal, widest; cuticle calcified, with many tubercles. Cephalon with 2 large and 2 small spines and numerous tubercles; lateral margins with several small spines; posterolateral margins rounded, but almost square. Pereonite 1 anterior margin with 2 widely-spaced sub-marginal spines, pereonites 2–4 with 4 sub-marginal spines, numerous tubercles between these spines, posterior margins with row many tubercles; pereonites 1–3 anterolateral margins smooth, pereonite 4 anterolateral margins with small spines; pereonite 2 with 3 pairs of small lateral spines, pereonite 3 with 2 pairs, pereonite 4 with 1 pair of spines; pereonites 5–7 dorsally with at least 1 pair of spines and numerous tubercles; pereonite 5 anterior margin with 2 pairs of widely-spaced spines, anterolateral margin square; pereonite 6 anterolateral margin with small lobes; pereonite 6 ventrally with no ornamentation; pereonite 7 ventrally with row of setae. Pleonite 1 with 1 pair of spines. Pleon as long as proximal width, lateral sides indent and posterior end coming to a rounded point, dorsally with several pairs of tubercles.

Antenna 1 damaged; article 1 elongate, distal end rounded, 1.8 times as long as wide, mesial margin with 5 SRS, surface with 5 PS, lateral margin with 8 SRS, distal margin with 1 long PS; article 2 0.5 times as long as article 1, 2.3 times as long as wide, lateral margin with 1 SRS, distomesial corner with 3 PS, mesial margin with 1 PS and 1 SS; article 3 0.9 times as long as article 1, mesial margin with 2 SRS. Antenna 2 damaged; article 1 lateral margin with 3 RS, mesial margin with 1 RS; article 2 0.6 times as long as article 1, distolateral margin with 2 SRS; article 3 as long as article 1, scale with 5 RS (1 sub-marginal), mesial margin with 3 SRS, distomesial margin with 7 SRS (5 in a clump, 2 separate); article 4 0.9 times as long as article 1, with no ornamentation.

Mandible lacinia mobilis and spine row absent; molar small, distally with 11 uni-serrate setae. Maxilla 1 lateral and mesial margins with fine SS; lateral lobe 1.7 times as wide as mesial lobe, distal margin with numerous fine SS, 8 RS, 2 dentate RS and 2 robust pectinate setae; mesial lobe distally with 1 SS and 2 long pectinate setae. Maxilla 2 lateral lobe margins with fine SS, distally with 4 long pectinate setae; middle lobe 0.9 times as wide as lateral lobe, distally with 4 long pectinate setae; mesial lobe 1.9 times as wide as lateral lobe, mesial and distal margins with fine SS, distally with 7 SS, 9 toothed setae and 1 long pectinate seta. Maxilliped coxa roughly triangular, 1.0 times as long as wide, 0.3 times as long as basis (including endite); basis elongate, 2.6 times as long as wide (including endite); endite with 7 coupling hooks, distally with 7 SS, 9 fan setae (distomesial one longest) and many fine SS; palp article 1 wide, shortest, 0.2 times as long as basal endite, distolateral margin with 1 SS, distomesial margin with 1 SS; article 2 5.0 times as long as and 1.3 as wide as article 1, 1.6 times as wide as basal endite, lateral margin with 11 SS (1 submarginal), mesial margin with 3 distally pappose setae and 1 long SS; article 3 2.5 times as long as and 0.8 times as wide as article 1, mesial margin with 4 long SS and 16 distally pappose setae; articles 4 and 5 rectangular; article 4 1.7 times as long as and 0.3 as wide as article 1, lateral margin with 3 SS, distomesial margin with 3 SS; article 5 narrow, setae missing, 1.3 times as long as and 0.1 times as wide as article 1; epipod 1.8 times as long as wide and as long as basis.

Pereopod 1 basis 7.2 times as long as wide, inferior margin with 7 SS, lateral surface with 1 SS, superior margin with 3 SS and 1 medial SRS; ischium 5.4 times as long as wide, inferior margin with 6 SS, lateral surface with 6 scattered SS, superior margin with 5 SS; merus 1.1 times as long as wide, inferior margin with 5 SS and 17 SRS, lateral surface with 1 SS, distosuperior margin with 2 SS; carpus 6.3 times as long as wide, inferior margin with 8 SS (lengths varying, all in proximal half), superior margin with 2 SS; propodus 9.9 times as long as wide, inferior margin with 12 SS, lateral surface with 4 SS, superior margin with 1 SS; dactylus 3.1 times as long as proximal width, superior margin with 4 SS.

Operculum 3.2 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with row of RS (possibly all SRS, given last one is), scattered SS and proximally with 3 plumose setae, surface with scattered SS, lateral margins with numerous plumose setae. Pleopod 3 exopod 1.1 times as long as endopod with row of fine SS, distally with 12 long plumose setae; endopod 1.8 times as long as wide with 18 long plumose setae. Pleopod 4 exopod distally with 5 long plumose setae; endopod oval, 1.3 times as long as wide. Pleopod 5 1.9 times as long as wide.

Appendix: D

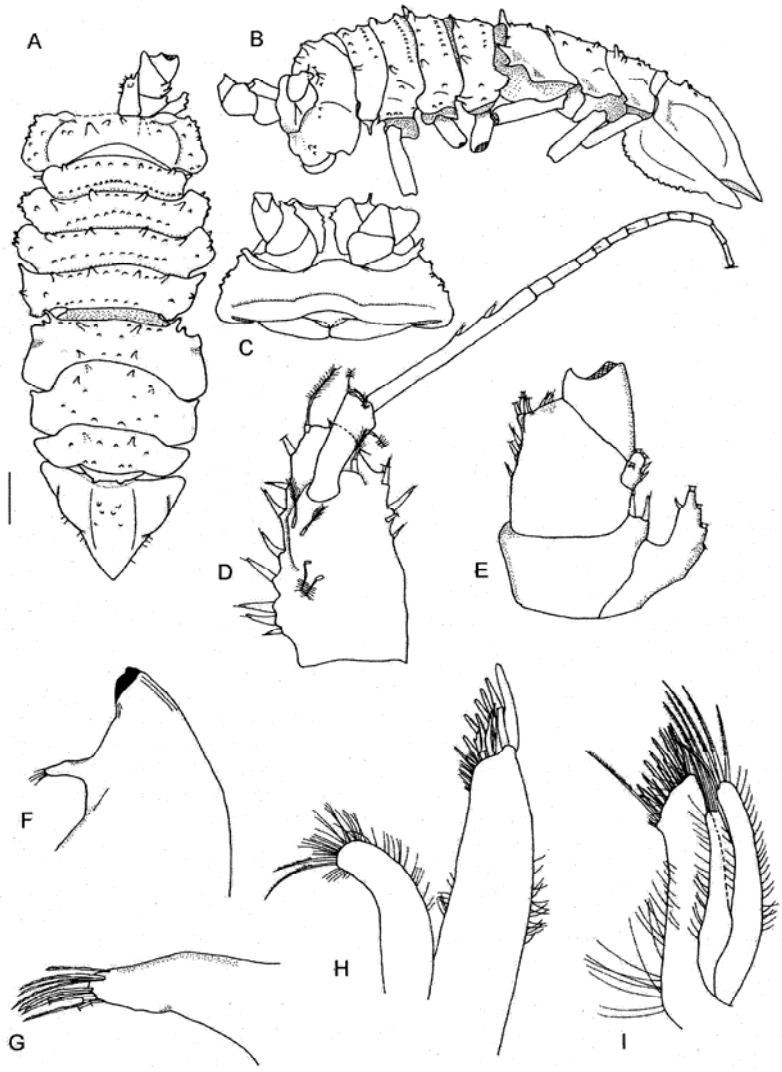

Figure 4. *Notopais euaxos* sp. nov. **A–C.** female holotype (8.5 mm; NIWA 23786), **D–I.** female paratype (12.5 mm; NIWA 23785). **A.** dorsal view; **B.** lateral view; **C.** ventral view of cephalon; **D.** left antenna 1; **E.** right antenna 2; **F.** left mandible; **G.** molar of left mandible; **H.** left maxilla 1; **I.** left maxilla 2. Scale bar = 1 mm, for dorsal and lateral views only.

Figure 4. *Notopais euaxos* sp. nov. **A–C.** holotype femelle (8.5 mm; NIWA 23786), **D–I.** paratype femelle (12.5 mm; NIWA 23785). **A.** vue dorsale ; **B.** vue latérale ; **C.** cephalon, vue ventrale ; **D.** antennule gauche ; **D.** antenne droite ; **F.** mandibule gauche ; **G.** molaire mandibule gauche ; **H.** maxillule gauche ; **I.** maxille gauche. Échelle = 1 mm, vue dorsale et latérale.

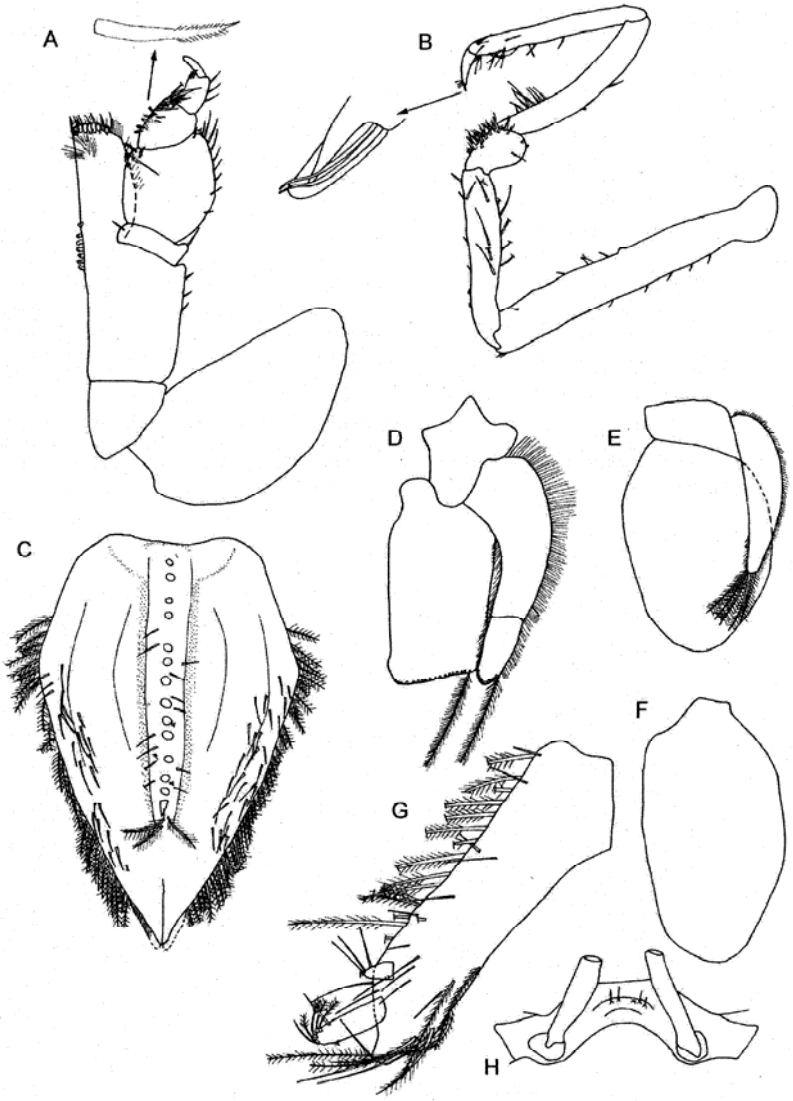

Figure 5. *Notopais euaxos* sp. nov. **A, D–G.** female paratype, **B, C & H.** female holotype. **A.** left maxilliped; **B.** right pereopod 1; **C.** operculum; **D.** left pleopod 3; **E.** left pleopod 4; **F.** left pleopod 5; **G.** left uropod; **H.** ventral view of pereonite 7.

Figure 5. *Notopais euaxos* sp. nov. **A, D–G.** paratype femelle, **B, C & H.** holotype femelle. **A.** maxillipède gauche ; **B.** péréiopode 1 gauche ; **C.** opercule ; **D.** pléopode 3 gauche ; **E.** pléopode 4 gauche ; **F.** pléopode 5 gauche ; **G.** uropode gauche ; **H.** péréionite 7 vue ventrale.

Uropod protopod 3.4 times as long as wide, margins subparallel, lateral margin provided with 8 SS and 13 plumose setae, mesial margin with 1 SS and 5 plumose setae, surface with 9 scattered SS and 1 plumose seta, distomesial angle produced, not extending past endopod, provided with 1 plumose seta and 2 SS; exopod small, 0.1 times as long as protopod, 0.4 times as long as endopod, with 4 SS; endopod 0.2 times as long as protopod, with 3 SS and 5 PS.

Remarks

See 'Remarks' for *N. echinatus*.

Distribution

Known only from type locality.

Etymology

The Greek word euaxos (easily broken), alluding to the frequently broken pedestal setae.

Acknowledgments

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A revision of the munnopsid genus *Bathybadistes* (Isopoda: Asellota: Munnopsidae) with two new species from the Southern Hemisphere

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Abstract

The originally designated taxa of *Bathybadistes* Hessler & Thistle, 1975 and related taxa have undergone a phylogenetic analysis to test the validity and composition of the genus. The result of the analysis supports the validity of *Bathybadistes*. Some species are now rendered to the status of *incertae sedis*. Two new species of *Bathybadistes* are described: *Bathybadistes andrewsi* n. sp. from 3253–3347 m off the west coast of New Zealand and *Bathybadistes fragilis* n. sp. from 4742–4745 m from the eastern Weddell Sea, Antarctica.

Introduction

The munnopsid genus *Bathybadistes* Hessler & Thistle, 1975 was established for their new species and a group previously assigned in the genus *Ilyarachna* Sars, 1870. Hessler & Thistle (1975) included eight species, of which seven names are valid (*Ilyarachna argentinae* Menzies, 1962 was synonymised with *Ilyarachna multispinosa* Menzies, 1962 by Wolff, 1962, p. 97). Hessler & Thistle (1975)

had reservations on their placement of three species (although they did not discuss why), these being *Ilyarachna scabra* Birstein, 1971, *Ilyarachna tuberculata* Birstein, 1971 and *Ilyarachna venusta* Birstein, 1971. In his review of the Munnopsidae, Kussakin (2003) synonymised *Bathybadistes* in part with *Ilyarachna* and in part with *Echinozone* Sars, 1897, and reassigned *B. scabra*, *B. tuberculata*, *B. venusta* and *B. longipes* (Birstein, 1963) to *Echinozone*.

This contribution seeks to resolve some of the problems surrounding the species composition of *Bathybadistes* by undertaking a phylogenetic analysis of all species that are currently part of, or previously have been placed in the genus. As well as re-diagnosing the genus, this paper also describes two new species from the southern hemisphere, *Bathybadistes andrewsi* n. sp. from off the west coast of New Zealand, which also features some scanning electron micrographs and the other, *Bathybadistes fragilis* n. sp. from the eastern Weddell Sea, Antarctica. New illustrations of the type specimens for *B. spinosissima* (Hansen, 1916) are also presented.

Methods

For the analysis, a data matrix was constructed in DELTA (Dallwitz *et al.* 1997) and a nexus file was generated for analysis in PAUP* version 4.0 (beta 10 for windows; Swofford, 2001). A treespace search (Swofford and Begle 1993; as in Reid 1996; Edgecombe *et al*. 2000) was conducted under a heuristic search method with 1000 random addition sequence repetitions (nreps=1000 addseq=random) saving no more than 3 trees of equal or 1 step greater than the minimum length tree at each iteration (nchuck=trees chuckscore=1 randomize=trees). The trees in memory then had their branches swapped and all minimum length trees were saved (hsearch nchuck=0 chuckscore=0 start=current). A strict consensus tree was generated. Bremer support (Bremer 1988; Bremer 1994) was performed to measure branch robustness. A decay index PAUP file was generated in MacClade version 4.03 (Maddison and Maddison 2001) under the same heuristic search constraints as mentioned above.

This file was then run in PAUP and the decay indices calculated. Trees were displayed in TreeView version 1.6.6 (Page 1996).

For *B. andrewsi* n. sp., the conserved holotype and dissected paratypes were illustrated using a Zeiss Stemi SV 11 dissecting microscope and a Nikon Optiphot-2 compound microscope, both fitted with a camera lucida. Descriptions were based on both the holotype and paratypes and are identified in the figure captions. For *B. fragilis* n. sp. the dissected holotype was illustrated using a Wild M5 dissecting microscope and a Leitz Dialux microscope, both equipped with a camera lucida. Illustrations of *B. spinosissima* were also prepared using the Wild M5 dissecting microscope. Written descriptions were prepared in DELTA and all ratios were calculated using the maximum widths and lengths for the segment unless otherwise mentioned in the text.

Previously fixed material used for scanning electron micrographs was dehydrated in an ethanol series in the same method as suggested by Felgenhauer (1987), with the specimens being air dried and mounted onto an entomological pin with super glue. Specimens were studied under a Leica S440 scanning electron microscope.

Abbreviations used in text are as follows: NIWA – National Institute of Water and Atmospheric Research; ZMH – Zoological Museum, Hamburg; ZMUC – Zoologisk Museum, University of Copenhagen; SEM– Scanning Electron Microscope; BS – broom setae; PLS – plumose setae; PS – pectinate setae; RSS – robust sensillate setae; RS – robust setae; SS – simple setae.

Phylogenetic Analysis

Taxa included

The ingroup consists of all species that were considered to belong to *Bathybadistes* according to Hessler and Thistle (1975), including those for which they held reservations. Also included are two species of *Notopais* Hodgson, 1910, the type species for *Echinozone*, *Echinozone coronata* (Sars, 1870) to test

Kussakin's reassignment of some former *Bathybadistes* to this genus and two species of *Ilyarachna*, including the type, *Ilyarachna longicornis* (Sars, 1864), as all except one species in Hessler and Thistle's (1975) grouping were originally described as *Ilyarachna* by their respective authors. The two new species described in this paper are also included in the analysis. See table 1 for the complete list.

Wilson and Thistle (1985) postulated that *Amuletta abyssorum* (Richardson, 1911) was the sister taxa to the *Ilyarachna*. In his subsequent phylogenetic analysis of the Munnopsidae, Wilson (1989), using *Ilyarachna* as the representative of Ilyarachnidae (then considered a family), found that this genus formed a polytomy with *Amuletta* Wilson & Thistle, 1985, *Betamorpha* Hessler & Thistle, 1975 and *Storthyngura* Vanhöffen, 1914. Based on this hypothesis, two species were selected for the outgroups: *A. abyssorum* and *Betamorpha characta* Hessler & Thistle, 1975.

Characters

The 27 morphological characters were used in the analysis, with data for the majority taken from illustrations in the literature. For some species, the type material was also referred to (see table 1 for literature and type material used). All characters were treated as unordered and unweighted, 21 characters were binary and 6 had 3 states; below, numbers in brackets represent how they were entered into the matrix (see table 2).

Character List

1. Pereonites 1–4 length: less than length of pereonites 5–7 (1); sub-equal to length of pereonites 5–7 (2); longer than length of pereonites 5–7 (3).
2. Dorso-centrally pereonite 5 length: shorter the pereonite 6 (1); sub-equal with pereonite 6 (2); longer than 6 (3).
3. Cephalon with spines: present (1); absent (2).

4. Anterior pereonites: with spines (1); without spines (2).

5. Posterior pereonites: with spines (1); pereonite 5 with spines only (2); without spines (3).

6. Spines/tubercles on pereonites: with apical setae (1); without apical setae (2).

7. Pereonite 5: lateral margins narrowing anteriorly, forming an elongation or neck (1; fig. 1A, see arrow); lateral margins not elongate or forming a neck (2; fig 1B).

8. Pereonites 5–7: lateral margins narrowing, pereonite margins distinct from each other (1; figs 1A, C and D); lateral margins not so narrow, pereonites 'fit' into each other, natasome not as reduced (2; fig. 1B).

9. Pereonites 5–7 lateral margins: rounded, sometimes almost square (1; fig. 1B); narrow, elongate, akin to a single spine (2; fig. 1C); jagged, with many spines (3; fig. 1D).

10. Antenna 1 article 3 length: less than article 1 (1); equal or more than article 1 (2).

11. Antenna 2 article 1: without spine-like robust seta/e (1); with spine-like robust seta/e (2).

12. Antenna 2 article 1: distolateral angle with no horn-like prominent spine (1); distolateral angle with horn-like prominent spine (2).

13. Mandibular palp: present (1); absent (2).

14. Incisor process: enlarged and rounded, no differentiation of cusps (1); dentate (2).

15. Left mandible with lacinia mobilis: present (1); absent (2).

16. Lacinia mobilis (if present): large, length sub-equal to that of incisor process (1); reduced, smaller than incisor process (2).

17. Mandibular molar: large, square, distally broad (1); small, narrow, flap-like (2).

18. Pereopod 1: robust, carpus expanded (1; fig. 1E); not robust, more ambulatory, carpus not expanded (2; fig. 1F).

19. Pereopod 1 carpus, inferior margin with: a continual row of setae (1; fig. 1E); not a continual row of setae, setae more dominant in proximal half (2; fig. 1F).

20. Pereopod 5 carpus length: less than twice width (1); more than twice width (2).
21. Pleon: with dorsal spines (1); with dorsal tubercles (2); without dorsal ornamentation (3).
22. Pleon anterolateral margin: with spine (1; fig. 1C and D, see arrows); smooth, with no anterolateral spine (2).
23. Pleopod 3 endopod: 3 or less plumose setae (1); more than 3 plumose setae (2).
24. Pleopod 3 exopod distally with: more than 3 plumose setae (1); 2 or 3 plumose setae (2); 1 plumose seta (3).
25. Uropod: biramous (1); uniramous (2).
26. Uropod protopod: flattened (1); tubular (2).
27. Uropod exopod: tiny or rudimentary (1); large, articulating article (2).

Ratios of pereonite sizes (characters 1 and 2) could be useful in separating genera. Within the Ilyarachninae, many species have spines present on their cephalon (character 3). *E. longipes* and *E. scabra* are considered to have tubercles on their cephalon and not spines and are coded as such.

In their generic description of *Bathybadistes*, Hessler and Thistle (1975) stated that the genus can be diagnosed by the dorsal surface of the pereonites with pedestals (in this analysis, considered as spines, characters 4 and 5) topped with a seta (character 6); and the natasomal pereonites reduced (character 8, figs 1A, C and D). The reduction of these posterior pereonites has led to some interesting patterns and features of the lateral margins (characters 7 and 9, figs 1A, C and D) as opposed to the more enlarged general *Ilyarachna* shape (character 8, fig. 1B).

Article 3 of antenna 1 is usually smaller than article 1 (character 10), except in the group of species that Kussakin (2003) had moved from *Bathybadistes* into *Echinozone*. Characters 11 and 12 deal with ornamentation of article 1 of antenna 2.

In the munnopsids, the mandible displays a wide variety of morphologies and in the Ilyarachninae it is characterised by the massive, rounded incisor process (character 14 state 1) and the narrowed mandibular molar (character 17 state 2). Due to the range of morphologies seen within the sub-family, mandibular characters have featured in all of Sars' generic descriptions (for example, see Sars 1897) and both the presence and absence of the mandibular palp were included in the description of *Bathybadistes* (Hessler & Thistle 1975). Characters 13–17 refer to the differences in mandibular morphologies found amongst these animals.

Appendages of deep-water asellotans are frequently damaged or lost during the collecting process and pereopods are quite often absent. In ilyarachnids often only pereopod 1 and the odd natatory pereopod remains while pereopods 2–4 are almost always lost. Consequently it is pereopod 1 which is most commonly illustrated, followed by a natatory pereopod, usually 5 or 6. A robust pereopod 1 and an expanded carpus with a continual row of setae are characteristic of Kussakin's (2003) group of former *Bathybadistes* (characters 18 and 19 respectively, figs 1E and F). The carpus of pereopod 5 is expanded, but the degree of expansion with respect to the length differs in different species (character 20).

Pleon shape and ornamentation (characters 21–22) could prove to be useful in grouping these animals and have not previously been mentioned in the description of *Bathybadistes*. One possible synapomorphy that emerges amongst those species retained in Bathybadistes is a spine on the anterolateral margins of the pleon (character 22, fig. 1C).

Characters 23 and 24 deal with pleopods; pleopod 3 with 3 long plumose setae (character 23) on the endopod is the plesiomorphic state in the Janiroidea although, Wilson (1989) considers it to be an apomorphy within the Munnopsidae.

A synapomorphy for the sub-family Ilyarachninae is the flattened uropod protopod as opposed to the oval protopod (in cross section) found in genera such as *Amuletta* and *Betamorpha* (see Wilson and Hessler 1985) (character 26). In their generic description, Hessler and Thistle (1975) also referred to the uropods being either uniramous or biramous (character 25) and if they were biramous, the exopod was a tiny bump (character 27). This tiny bump equates to a rudimentary exopod and can be found in *Bathybadistes* and in several other members of the sub-family.

Results and Discussion

The analysis generated 106 equally most parsimonious trees, each of 49 steps, with a consistency index of 0.633 and a retention index of 0.809. The strict consensus tree is well resolved (fig. 2) with all 6 species of *Bathybadistes* resolving into a polytomy.

The following results refer to the strict consensus tree (fig. 2) with the clade number mentioned. For a full description of characters defining clades see table 3, as not all clades will be discussed here in detail. This tree shows there are numerous characters to support the generic status of *Bathybadistes* (clade 8, bremer value = 3). This clade is defined by: cephalon with spines; posterior pereonites with spines; lateral margins of pereonites 5–7 narrowing, pereonite margins distinct from each other; pereonites 5–7 lateral margins jagged with many spines; pleon with dorsal spines; and the anterolateral margin of the pleon with a spine. The jagged lateral margins of pereonites 5–7 is not considered a generic character for *Bathybadistes* (character 9 state 3), as other members of this genus have the lateral margins of pereonites 5–7 narrow and elongate, similar to a single spine (character 9 state 2). Clade 2 (bremer value = 6) is made up of those former members of *Bathybadistes* that Kussakin (2003) moved out into *Echinozone* and is the most basal ingroup clade in this analysis. This clade does not include the type for the genus *Echinozone*, *E. coronata*, and thus cannot be considered as this genus. The characters which define clade 2 are: pereonite 5

dorso-centrally longer than pereonite 6; pereonite 5 narrowing anteriorly forming an elongation, or neck; pereonites 5–7 lateral margins narrowing, pereonite margins distinct from each other; antenna 1 article 3 length equal or longer than article 1; pereopod 5 carpus length more than twice width; pleon with dorsal tubercles; and the uropod is uniramous. This analysis strongly supports the validity of *Bathybadistes*.

Taxonomy

MUNNOPSIDAE Lilljeborg, 1864

Subfamily Ilyarachninae Hansen, 1916

***Bathybadistes* Hessler & Thistle, 1975**

Bathybadistes Hessler & Thistle, 1975: 163.

Type species: *Bathybadistes hoplitis* Hessler & Thistle, 1975, by original designation.

Diagnosis: Pereonites with spines, each topped with an apical seta; pereonites 5–7 lateral margins narrow, natasome somewhat reduced; mandible incisor massive, rounded; lacinia mobilis reduced; mandibular palp present, slender; pleon in dorsal view longer than wide, with dorsal spines; anterolateral margin of pleon with spine; uropod with rudimentary exopod.

Description: Pereonites with spines, each topped with an apical seta; pereonites 5–7 lateral margins narrow and distinct from each other, natasome somewhat reduced; antenna 2 article 1 with distolateral spine topped with robust seta; mandible incisor massive, rounded; lacinia mobilis reduced; spine row and mandibular palp both present; pereopods 5–6 with carpus expanded, paddle-like, propodus elongate; at least superior margin of ischium and both margins of carpus and inferior margin of propodus with row of plumose setae; pereopod 7

carpus and propodus slender, setation generally similar to that of pereopods 5–6; pleon in dorsal view longer than wide, with dorsal spines; anterolateral margins of the pleon each with single spine; operculum large, sub-diamond in shape, with median keel; pleopod 5 simple lobe; uropod biramous, with rudimentary exopod.

Species included: *Bathybadistes andrewsi* n. sp.; *B. fragilis* n. sp.; *B. gurjanovae* (Menzies, 1962); *B. hoplitis* Hessler & Thistle, 1975 (type species); *B. multispinosa* (Menzies, 1962); and *B. spinosissima* (Hansen, 1916).

Species now excluded: Kussakin (2003) was correct to remove the four similar species, *E. scabra*, *E. tuberculata*, *E. venusta* and *E. longipes* from *Bathybadistes*. As *E. coronata* does not fall within their distinct clade (fig. 2, clade 2), it would be incorrect to consider them apart of *Echinozone* and thus they are removed. As this paper deals with *Bathybadistes*, it is not within its scope to redefine the generic status of this clade that the authors now consider as *incertae sedis*.

Remarks: *Bathybadistes* can be distinguished from other Ilyarachninae genera by: pereonites dorsally with spines, each possessing an apical seta (which Hessler and Thistle [1975] referred to as a pedestal setae); pereonites 5–7 with narrow lateral margins, distinct from each other, natasome somewhat reduced; anterolateral margin of the pleon with a spine; and uropod with rudimentary exopod.

The dorsal spines of *Bathybadistes*, each with a distal seta, are similar to those found in many species of *Notopais* Hodgson, 1910, however *Notopais* does not have a mandibular palp and the reduction of the posterior three pereonites seen as in *Bathybadistes*. The patterning and spines found on the lateral margins of the posterior three pereonites is unique in the Ilyarachninae, although the elongated spine-like lateral margin is not unique within the Munnopsidae as it is displayed by many other genera, e.g. those in the Acanthopcopinae and Storthyngurinae.

Bathybadistes is distributed worldwide and is found between depths of 2700 to 5024 metres.

Key to the species of *Bathybadistes*

1. Pereonites 5–7 lateral margins each narrowing to a single elongate narrow extension……..2

   Pereonites 5–7 lateral margins jagged, laterally with several small spines……3

2. Pereonites 1–3 anterior margins with 4 large sub-equal spines, pereonite 5 and 6 with 4 and pereonite 7 with 6 spines; pereonite 6 dorsally longer that pereonite 5; pleon surface spiny with row of 4 spines towards anterior margin, centrally with a pair of spines ……*B. fragilis* n. sp.

   Pereonites 1–3 anterior margins with 2 large central spines, 5–7 centrally with 2 spines; pereonite 6 dorsal length sub-equal to 5; pleon surface granular with 4 central spines……..…..*B. andrewsi* n. sp.

3. Pereonites 5–7 lateral margins more rounded with small protrusions, jagged margins less defined. ..……..……4

   Pereonites 5–7 lateral margins less rounded, more angular with larger protrusions, jagged margins well defined ..……..5

4. Pereonite 5 dorsally longer than 6; pleon with 2 rows of small spines down either side of central margin ……..…*B. gurjanovae*

   Pereonite 6 dorsally longer than 5; pleon with numerous small spines scattered……....*B.multispinosa*

5. Laterally pereonites 3 and 4 with many protrusions; pereonite 7 narrow strip, length similar throughout width; pleon distal margin coming to a narrow point……...*B. spinosissima*

   Laterally pereonites 3 and 4 with few protrusions; pereonite 7 longer centrally than laterally; pleon distal margin rounded ……..*B. hoplitis*

***Bathybadistes andrewsi* n. sp. (figs 3-6)**

Material examined.— Holotype. Male (4.0 mm), Stn P937, Bellona Trough, Tasman Sea, New Zealand, 41º19.2'S, 166º27.9'E, 21 April 1980, epibenthic sled, 3253–3347 m, R.V. *Tangaroa* (NIWA XXXX). Paratypes 5 males (dissected paratype 3.5 mm), 6 females (dissected paratype 5.0 mm), 3 fragments, type locality (NIWA XXXX).

Description

Holotype Male Body about 2.5 times as long as width of pereonite 2 (from spine to spine); widest at pereonite 5; cuticle calcified, granulated. Cephalon with 14 spines, 6 centrally and 8 laterally; posterolateral margins broadly rounded; ridge encompassing antennae with poorly developed extensions near article 1 of both antennae. Frontal arch narrowing towards inter-antennal gap; clypeus thick, broad; labrum oval, wider than long. Dorsally, pereonites 1–2 with 2 large and 2 smaller spines, pereonite 3 with 4 large spines, and pereonite 4 with 2 large and 4 smaller dorsal spines. Anterolateral margins of pereonites 1-3 smooth, pereonite 4 with pair of small spines. Lateral margins of pereonite 2–3 with pairs of small spines, pereonite 2 with additional pair of sub-marginal spines. Coxae of pereopods 1, 2 and 4 each with spine. Pereonite 5 anterior margin smooth; posterior margin with central pair of spines; anterolateral margin rounded. Pereonites 5–7 dorsally with pair of spines, pereonites 5–6 with additional pair of tubercles. Pereonites 5–7 lateral margins with posterior facing narrow lateral spine-like extensions. Pleon 1.4 times as long as proximal width, anterior two-thirds rounded, swollen, with 4 small dorsal spines, distal third triangular, somewhat flattened, coming to a narrow posterior tip, which points up. Ventrally pereonite 7 with 2 spines on central swelling between pereopods.

Paratype Female Antenna 1 of 9 articles; article 1 slightly elongate, distal end rounded points, concave in centre, 1.4 times as long as wide, mesial margin with 2 distal RSS, surface with 3 BS, lateral margin with 4 RSS and 2 SS; article 2 elongate, 0.5 times as long article 1, and 3.6 times as long as wide, with 1 seta (on distomesial margin); remaining articles all rectangular, length varying;

article 3 mesial margin with 1 SS; article 4 mesial margin with 2 BS; article 6 lateral margin with 1 SS; article 8 with an aesthetasc; terminal article with 1 aesthetasc and 2 SS. Male antenna 1 similar, of 22 articles; article 1 ratios similar to female; article 1 with 10 setae (distomesial margin with 1 BS and 1 RSS, surface with 2 BS, lateral margin with 5 RSS and 1 BS); article 2 2.2 times as long as wide; distal margin with 1 BS; article 4 mesial margin with 1 BS; from article 9 onwards, each article has 1 aesthetasc. Antenna 2 not complete. Antenna 2 articles 1–3 more or less triangular; article 1 lateral margin with a robust setae on short distolateral spine; article 2 0.9 times as long as article 1, with spine similar to article 1; article 3 1.5 times as long as article 1, scale with 2 RS; article 4 small, 1.1 times as long as article 1, with no ornamentation.

Left and right mandible not identical; without microtrichs; on left mandible, lacinia mobilis reduced and smooth, rounded; spine row with 7 spines; molar large, terminated with 1 SS and 4 bi-serrate setae; mandibular palp short, not extending beyond incisor, article 1 with 5 SS (on left mandible, 1 SS on right) and article 3 with 2 SS (1 long and 1 shorter). Maxilla 1 lateral and mesial margins with fine simple setae; lateral lobe 1.8 times as wide as mesial lobe, distal margin with few fine simple setae and 7 RS, 2 dentate RS and 3 pectinate RS; mesial lobe terminated with 6 SS and 2 long PS. Maxilla 2 lateral lobe margins with fine simple setae, distally with 4 long PS; middle lobe 1.4 times as wide as lateral lobe, distally with 4 long PS; mesial lobe 2.6 times as wide as lateral lobe, margins and surface with fine simple setae, terminated with 8 blunted SS, 8 toothed setae and 1 very long PS. Maxilliped coxa square, as long as wide, and 0.4 times as long as basis (including endite); basis elongate, 3.0 times as long as wide (including endite); endite with 5 coupling hooks, and distally with 4 SS, 2 toothed setae, 6 fan setae (distomesial one bigger than other 5), and many fine simple setae; palp widens proximally, then tapers; palp article 1 0.3 times as long as basal endite, rectangular, distomesial margin with 1 SS; article 2 longer laterally than mesially, 3.4 times as long as, and 1.2 times as wide as article 1, and 1.6 times as wide as basal endite, lateral margin with 4 SS, mesial margin with 5 distally pappose setae; article 3 1.6 times as long as, and 0.9 times as wide as article 1, with 1 SS on lateral margin, and mesial margin

with 3 SS and 6 distally pappose setae; articles 4 and 5 rectangular; article 4 1.1 times as long, and 0.4 as wide as article 1, lateral margin with 1 SS, distal margin with 1 SS and 1 distally pappose seta; article 5 shortest, 0.9 times as long as, and 0.2 times as wide as article 1, with 5 terminal distally pappose setae; epipod 1.7 times as long as wide, and 1.1 times as long as basis, margins with many microtrichs and few scattered simple setae, surface with 1 SS.

Pereopod 1 basis 5.8 times as long as wide, inferior margin with 14 setae (11 evenly spread SS, 1 long SS at mid-point, 2 RSS on distal margin), superior margin with 19 SS and 4 RS; ischium 3.6 times as long as wide, inferior margin with 4 SS (1 at mid-point, 3 in clump on distal margin), lateral face with 4 SS, and superior margin with 2 RSS and 4 SS; merus 1.3 times as long as wide, inferior margin with 13 SS, and distosuperior margin with 2 RSS and 5 SS; carpus 4.3 times as long as wide, inferior margin with 19 SS (lengths varying), superior margin with 8 SS (3 in clump on distal margin); propodus 6.2 times as long as wide, inferior margin with 12 SS, lateral face with 2 SS, and superior margin with 2 SS; dactylus 3.2 times as long as proximal width, superior margin with 3 SS (in distal clump).

Pereopod 5 basis 3.9 times as long as wide, inferior margin with 3 SS and 3 BS, and superior margin with 17 SS; ischium 3 times as long as wide, inferior margin with 9 SS, lateral face with 3 SS, superior margin slightly convex; merus 1.1 times as long as wide, inferior margin with 12 6 SS and 6 RS, lateral face with 3 small SS, distosuperior margin with 3 SS; carpus 1.5 times as long as wide, additionally inferior margin with 4 SS, distosuperior margin with 1 RSS; propodus elongate, 4.7 times as long as wide, additionally inferior margin with 1 SS on distoinferior corner, plumose setae on this margin are weekly plumose, and superior margin with 15 setae (14 SS, of which 3 are sub-marginal, 1 BS on distosuperior margin); dactylus 5.6 times as long as proximal width, with 5 SS (4 in clump in distal half).

Pereopod 7 basis 5.5 times as long as wide, inferior margin with 21 long SS, superior margin with 2 SS; ischium 4 times as long as wide, inferior margin with 14 SS, and superior margin with 7 setae (6 sparsely setulose PLS and 1 SS); merus 1.5 times as long as wide, inferior margin with 7 SS, distosuperior margin

with 2 SS; carpus 5.1 times as long as wide, inferior margin with 6 SS, lateral face with 1 SS, and superior margin with 2 setae (1 RS in distal corner, the other SS), plumose setae on carpus are sparsely plumose; propodus 9.0 times as long as wide, inferior margin also with 2 SS on distoinferior margin), lateral face with 7 small SS, scattered, and distosuperior margin with 4 setae (3 SS and 1 BS); dactylus 8.6 times as long as proximal width, with 5 SS (all in distal half, 3 on superior margin, 2 on inferior margin).

Male pleopod 1 3.6 times as long as proximal width, lateral margins indent 0.5 from proximal end, either side of central margin with 6 setae (4 RSS and 2 SS + 3 RSS and 3 SS), distally with 31 SS (15 + 16 - both sides have 3 SS on distal surface) and pair of lobes going over distolateral horns, horns with fringe of fine simple setae on mesial margins. Male pleopod 2 protopod 3.3 times as long as wide, lateral margin with 3 SS (in proximal half) and 6 PLS, surface with 2 PLS, mesial margin with 6 PLS, 1 SS and many fine SS), distally with lamellar extension; exopod elongate, 0.2 times as long as protopod; stylet 0.6 times as long as protopod, terminating to a point, sperm duct 0.5 times as long as stylet. Operculum 2.3 times as long as proximal width, distally with medial excision and veined lamellar extension, medial keel provided with row of robust setae, distal surface with 4 PLS (at least, 3 are broken) and few scattered simple setae, lateral margins with numerous plumose setae and 3 simple proximolateral setae (each side). Pleopod 3 exopod narrowing, 1.5 times as long as endopod, laterally with row of fine simple setae, distally with 7 long PLS and 1 sub-marginal SS; endopod 2.6 times as long as wide, with 3 long PLS. Pleopod 4 exopod slender, shorter than endopod, distal point at 0.8 times endopod length, margins with fringe of fine simple setae, distally with 3 terminal long PLS; endopod oval, 1.7 times as long as wide. Pleopod 5 1.8 times as long as wide.

Uropod protopod 2.3 times as long as wide, sub-triangular, distal end rounded, lateral margin straight with 18 setae (10 PLS, 6 SS and 2 RS at most distal point), mesial margin with 1 PLS, surface with 1 PLS; exopod rudimentary, with 3 SS; endopod 0.2 times as long as protopod, with 9 setae (3 SS and 6 BS).

Remarks

Bathybadistes andrewsi n. sp. is most similar to *Bathybadistes fragilis* n. sp. (described below) and these two species are easily distinguished from all other *Bathybadistes* by the shape of the lateral margins of pereonites 5–7 and the prominent dorsal spines. They share many similarities, such as having a highly granular body surface; large prominent spines on the dorsal surface of the pereonites; narrow and elongate lateral margins of pereonites 5–7; and the distal tip of the pleon pointing upwards in both species. *B. andrewsi* can be distinguished from *B. fragilis* by: the unique dorsal spine pattern on the pereonites and pleon; antenna 1 article 1 has a less angular lateral margin and a different arrangement of setae; no broom setae on the basis of pereopod 7; and more long plumose setae on the exopods of pleonites 3 and 4.

The SEMs of *B. andrewsi* have revealed several characters which has not only increased our knowledge of these animals, but could also be phylogenetically informative. The female operculum of the Ilyarachninae has a medial boat-shaped keel which often (but not always) has a row of robust setae. The cuticular surface of the operculum changes (fig. 6A), with the keel being covered in scales as opposed to the rest of the operculum which is relatively smooth. The distally pappose setae of the mesial margin of the maxilliped palp, have been illustrated for several other species within the family Munnopsidae (for example, see *Coperonus pulcher* Brandt, 1992; *Notopais zealandica* Merrin, 2004; and *Storthyngura parka* Malyutina & Wägele, 2001). SEMs show that such setae are a complex structure of many tiny lobes (figs 6C and D). These setae occur in many munnopsidid genera, but as yet, its phylogenetic significance is unknown. The rudimentary uropodal exopod of *Bathybadistes* occurs in other genera of the Ilyarachninae (e.g. *Ilyarachna hirticeps* Sars, 1870, see Svavarsson 1988). The exopod of *B. andrewsi* (fig. 6E) is fused and sunken into the uropod with the setae embedded into it, but whether this structure is similar to that found in *I. hirticeps* is, as yet, unknown.

Distribution

Known only from the type locality.

Etymology

For Neil Andrews, SEM technician at the University of Canterbury, in thanks and recognition of his assistance to the first author in taking the scanning electron micrographs.

***Bathybadistes fragilis* n. sp. (figs 7–11)**

Material Examined. — Holotype. Male (4.9 mm), St. 136-4-S, northern Weddell Sea, Antarctica, 64°1.45–51'S, 39°6.66–88'W, 4742–4745 m, RV *Polarstern* (ZHM K-40785).

Description

Holotype Male Body about 2.8 times as long as greatest width (from spine to spine) of pereonite 2; widest at pereonite 5; cuticle calcified, granulated; each body spine topped with an elongate robust seta not shorter than spine. Cephalon with 12 spines, 6 centrally and 6 laterally; posterolateral margins broadly truncate; ridge encompassing antennae with no extension. Frontal arch high, narrowing towards inter-antennal gap; clypeus thick, broad; labrum oval, wider than long. Dorsally pereonites 1–3 each with 4 well developed spines near anterior margin, pereonite 4 anteriorly with 2 spines and posteriorly with 4. Laterally pereonites 2–4 with 2 pairs of spines (1 pair is sub-marginal). Coxae of pereopods 1–4 with anterolateral spines. Pereonite 5 anterior margin smooth; anterolateral margin rounded; dorsally pereonite 5 dorsally with pair of spines, pereonites 6 and 7 with 2 pairs of spines, and pereonites 5 and 7 each with additional pair of sub-marginal lateral spines. Pereonites 5–7 lateral margins with posterior facing elongate lateral extensions. Pleon 1.5 times as long as proximal width, anterior two-thirds rounded, swollen, with 6 spines, distal third triangular, flattened, coming to a narrow tip, posterior tip of pleon pointing up. Ventrally pereonite 7 with 2 spines on central swelling between pereopods.

Antenna 1 of 21 articles; article 1 elongate, distolateral lobe distally truncated, 1.4 times as long as wide, mesial margin with 1 BS and 1 RS, surface with 2 BS, lateral margin with 1 RS and 2 SS, distal margin with 1 RSS and 1

BS; article 2 elongate, 0.7 times as long article 1, and 3.3 times as long as wide, with 3 setae (1 SS on mesial margin, 2 BS on distolateral margin); remaining articles all rectangular, length varying; article 3 with 1 SS (on distomesial margin); from article 8, most have an aesthetasc. Antenna 2 articles 1–3 triangular; article 1 lateral margin with 1 RS on short distolateral spine; article 2 1.2 times as long as article 1, with lateral spine smaller than in article 1; article 3 2.0 times as long as article 1, scale on lateral margin with 1 RS; article 4 slightly elongate, 2.2 times as long as article 1, with no ornamentation; article 5 23.4 times as long as article 1, with 5 scattered RS; article 6 24.6 times as long as article 1, with 7 scattered RS; flagellum broken, but existing part of 37 articles.

Mandible without microtrichs; lacinia mobilis rounded, elongate, with 2 cusps; spine row with 6 spines (2 spines larger than other 4); molar terminated with 1 seta; mandibular palp extending beyond incisor, article 1 with 1 seta, article 3 with 1 distal SS. Maxilla 1 lateral lobe 1.9 times as wide as mesial lobe, distal margin with few fine simple setae, 9 RS and 3 dentate RS; mesial lobe terminated with many fine simple setae and 2 long PS. Maxilla 2 lateral lobe margins with fine simple setae, distally with 4 long setae; middle lobe 1.3 times as wide as lateral lobe, distally with 4 long setae; mesial lobe 2.0 times as wide as lateral lobe, margins with fine simple setae, terminated with many simple setae, 4 toothed setae and 1 long PS. Maxilliped coxa diamond-shape, 0.7 times as long as wide, and 0.2 times as long as basis (including endite); basis rectangular, 3.7 times as long as wide (including endite); endite with 2 coupling hooks, and distally with 3 fan setae and many fine simple setae; palp widens proximally, then tapers; palp article 1 sub-rectangular, 0.3 times as long as basal endite, distomesial margin with 1 SS; article 2 longer laterally than mesially, 4.0 times as long as, and 1.5 as wide as article 1, and 1.6 times as wide as basal endite, 3 SS on distal half of lateral margin, and mesial margin with 6 SS (2 sub-marginal); article 3 2.0 times as long as, and 1.2 times as wide as article 1, 11 distally pappose setae (at least); articles 4 and 5 rectangular; article 4 1.1 times as long, and 0.6 as wide as article 1, distal margin with 6 SS (on mesial side); article 5 small, narrow, 1.4 times as long as, and 0.2 times as wide as article 1,

with 6 terminal SS; epipod 1.6 times as long as wide, and 1.1 times as long as basis, lateral margin with 1 SS.

Pereopod 1 basis 6.0 times as long as wide, inferior margin with 10 setae (9 SS and 1 BS), superior margin with 3 setae (1 small SS at mid-point, 2 RSS on distosuperior margin); ischium 5 times as long as wide, inferior margin with 3 SS, and superior margin with 2 long RSS; merus 0.8 times as long as wide, inferior margin with 8 SS, and distosuperior margin with 3 setae (1 RSS and 2 SS); carpus 5.8 times as long as wide, inferior margin with 11 SS, superior margin with 3 SS (1 at mid-point, 2 on distosuperior margin); propodus 5.8 times as long as wide, inferior margin with 5 SS, and superior margin with 7 SS; dactylus 3.0 times as long as proximal width, superior margin with 3 small SS.

Pereopods 2-4 bases only intact; pereopod 2 basis 6.1 times as long as wide, inferior margin with 9 setae (7 SS and 2 RSS on distoinferior margin), superior margin with 8 setae (3 BS and 5 SS); pereopod 3 basis 1.2 times as long as wide, inferior margin with 1 distal BS, superior margin with 4 setae (2 proximal RSS and 2 distal SS); pereopod 4 basis 1.7 times as long as wide, inferior margin with 1 distal BS), superior margin with 1 SS.

Pereopod 5 basis 4.8 times as long as wide, inferior margin with 8 setae (6SS and 2 RSS on distoinferior margin), lateral face with 5 setae (3 BS and 2 SS), and superior margin with 1 SS; ischium 3.9 times as long as wide, inferior margin with 8 RS, superior margin convex; merus 1.2 times as long as wide, inferior margin with 7 RS, distosuperior margin with 1 SS; carpus 1.8 times as long as wide, inferior margin with 2 SS (both sub-marginal), superior margin with 1 RSS (distosuperior margin); propodus 4.3 times as long as wide, inferior margin with 2 SS, and distosuperior margin with 1 BS; dactylus 7.6 times as long as proximal width.

Pereopod 6 basis length 5.7 times as long as wide, inferior margin with 6 setae (4 SS and 2 BS), and superior margin with 9 SS (many very long); ischium 4.4 times as long as wide, inferior margin with 8 RS; 1.2 times as long as wide, inferior margin with 6 SS, distosuperior margin with 1 SS; carpus narrower than in pereopod 5, 2.2 times as long as wide, distosuperior margin with 1 additional RSS; propodus narrower and longer than in pereopod 5, 6.8 times as long as

wide, and superior margin with 5 setae (4 evenly spaced SS and 1 BS on distosuperior margin); dactylus 8.6 times as long as proximal width, with 3 small SS.

Pereopod 7 basis 6.6 times as long as wide, inferior margin with 8 SS, superior margin with 9 setae (5 sub-marginal BS in proximal half and 4 SS); ischium 5.4 times as long as wide, inferior margin with 9 SS, and superior margin with 6 PLS; merus 2.0 times as long as wide, inferior margin with 4 SS, distosuperior margin with 2 SS; carpus 5.3 times as long as wide, superior margin with 2 SS (in proximal half); propodus 11.0 times as long as wide, distoinferior margin with 2 SS, and superior margin with 3 setae (2 SS and on distosuperior corner, 1 BS); dactylus 11.5 times as long as proximal width, with 6 setae (3 long SS and in a distal clump, 3 small SS).

Pleopod 1 3.5 times as long as proximal width, lateral margins indent 0.5 from proximal end, either side of centre margin with 13 SS (6 SS + 7 – 1 BS and 6 SS), distal ends with 26 SS (12+14). Male pleopod 2 protopod 3.1 times as long as wide, lateral margin with 2 SS (at proximal end), lateral margin with row of plumose setae, surface with 4 PLS, mesial margin with 1 PLS; exopod elongate and hooked, 0.2 times as long as protopod; stylet 0.6 times as long as protopod, terminating to a point, sperm duct 0.6 times as long as stylet. Pleopod 3 exopod narrowing, 1.5 times length of endopod, with row of fine simple setae, distally with 6 long PLS and 1 sub-marginal SS; endopod 2.4 times as long as wide, with 3 long PLS. Pleopod 4 exopod slender, shorter than endopod, its distal point at 0.8 times endopod length, lateral margin with fringe of fine simple setae and distally with 2 long PLS; endopod oval, 1.7 times as long as wide. Pleopod 5 1.7 times as long as wide.

Uropod protopod 2.2 times as long as wide, sub-triangular, distal end rounded, smooth, lateral margin provided with 10 setae (7 long PLS and 3 SS), distal margin with 3 long PLS); endopod 0.4 times as long as protopod; exopod rudimentary, with 2 SS.

Remarks

Bathybadistes fragilis sp. nov. is most closely related to *B. andrewsi* and for further discussion please refer to remarks section for *B. andrewsi*.

Distribution

Known only from the type locality.

Etymology

From Latin, fragilis, referring to the fragility of these animals.

***Bathybadistes spinosissima* (fig. 12)**

Ilyarachna spinosissima Hansen, 1916: 127-128, pl. XI, figs 10a-10e, pl. XII, figs 1a-1c. – Kussakin, 2003: 236-237, fig. 170.
Bathybadistes spinosissima. – Hessler & Thistle, 1975: 163

Material examined. — Syntypes. Female (6 mm) Ingolf St.36, Davis Strait, 61º50'N 56 21'W, 1435 fathoms, ZMUC CRU 9248. Male (3.8 mm), Ingolf St.38, south of Davis Strait, 59º12'N 51º05'W, 1870 fathoms, ZMUC CRU 8212.

Presented here in this paper are new illustrations of Hansen's syntypes for the species. Since no new material has been found, we will not attempt to redescribe the species, but no re-illustrations of the type material have occurred since Hansen's (1916) original description. Re-examination of the type material has bought to light the presence of a tiny, rudimentary uropodal exopod, which is described as absent in Hansen's original description. This is further conformation that this species belongs in *Bathybadistes*.

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Polarstern; Dr Jørgen Olesen (ZMUC) who kindly sent the type material of *B. spinosissima*; Neil Andrews (University of Canterbury) for his assistance in undertaking the SEM work; Niel Bruce (NIWA), Buz Wilson (Australian Museum) and the anonymous reviewers for their valuable comments. Funding came from a University of Canterbury Doctoral scholarship (KLM) and German Science Foundation grants Br 1121/20-1-3 and 436RUS 17/19/04 (AB). This is ANDEEP publication #46.

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Table 1. Taxa used in the phylogenetic analysis. * indicates type species for the genus.

Species	Literature references	Type material studied
Bathybadistes andrewsi n. sp.	N/A	Y
B. fragilis n. sp.	N/A	Y
B. gurjanovae (Menzies, 1962)	Menzies 1962	N
*B. hoplitis** Hessler & Thistle, 1975	Hessler & Thistle 1975	N
B. multispinosa (Menzies, 1962)	Menzies 1962	N
B. spinosissima (Hansen, 1916)	Hansen 1916; Menzies 1962	Y
*Echinozone coronata** (Sars, 1870)	Sars 1897	Y
E. longipes (Birstein, 1963)	Birstein 1963	N
E. scabra (Birstein, 1971)	Birstein 1971	N
E. tuberculata (Birstein, 1971)	Birstein 1971	N
E. venusta (Birstein, 1971)	Birstein 1971	N
Ilyarachna hirticeps Sars, 1870	Sars 1897; Svavarsson 1988	Y
*I. longicornis** (Sars, 1864)	Sars 1897	Y
Notopais minya Merrin, 2004	Merrin 2004	Y
*N. spicata** Hodgson, 1910	Merrin 2004; Schulz 1976. Additional material was also studied.	Y
*Amuletta abyssorum** (Richardson, 1911)	Wilson & Thistle 1985	N
*Betamorpha characta** Hessler & Thistle, 1975	Hessler & Thistle 1975; Thistle & Hessler 1977	N

Table 2. Character matrix of 17 taxa and 27 characters used in this analysis. Respective states are represented in the matrix as either 1, 2 or 3, with unknowns being represented by a '?' (entered as an 'U' in DELTA) and inapplicable by a '-'.

Taxa	Characters		
	1234567891	1234567892	1234567
Bathybadistes andrewsi	3111112121	2111122221	1111111
B. fragilis	3111112121	2111122221	1111111
B. gurjanovae	2311112131	2111122???	11??111
B. hoplitis	3211112131	21111222??	11??111
B. multispinosa	?111112131	??11122???	11??111
B. spinosissima	3211112131	21111222??	11??111
Echinozone coronata	3121222211	2121122221	3221112
E. longipes	2322311112	21212-2112	221121-
E. scabra	3321311112	2121122211?	222121-
E. tuberculata	3312211112	21212-211?	221121-
E. venusta	3311111112	2121122112	222121-
Ilyarachna hirticeps	11223-2211	2111122221	3211111
I. longicornis	11223-2211	2111122221	3211111
Notopais minya	1111312211	22212-2221	3221112
N. spicata	3111212211	2221122222	3221112
Amuletta abyssorum	11223-2211	1-2211111?	3221122
Betamorpha characta	31223-2211	1-12111?1	3221122

Table 3. Character states defining clades or terminal taxa in the strict consensus tree (fig. 2). Those characters with a superscript 1 refers to a transformation from state 2 to 1 and those with a superscript 2 refers to a transformation from state 1 to 2. Characters in **bold** have a CI=1.

Clade number or terminal taxa	Character transformation
1	4^{1} **11^{2} 14^{1} 16^{2} 17^{2} 26^{1}**
2	$2^{1>3}$ **7^{1}** 8^{1} **10^{2}** 20^{2} **$21^{3>2}$ 25^{2}**
3	4^{2} 15^{2} 23^{1}
4	18^{2} **19^{2}**
E. coronata	$1^{3>2}$ **6^{2}**
5	3^{1} **12^{2}**
6	13^{1} 23^{1} **27^{1}**
7	$1^{3>1}$ 4^{2}
8	3^{1} $5^{3>1}$ 8^{1} $9^{1>3}$ **$21^{3>1}$ 22^{1}**

Figure Captions

Fig. 1. A, *Echinozone venusta* (Birstein, 1971) (modified after Birstein 1971); B, *Ilyarachna longicornis* (Sars, 1864) (modified after Sars 1897); C, *Bathybadistes andrewsi* n. sp.; D, *Bathybadistes spinosissima* (Hansen, 1916) (modified after Menzies 1962); E, pereopod 1 of *E. venusta* (modified after Birstein 1971); F, pereopod 1 of *B. andrewsi* n. sp.

Fig. 2. A strict consensus of 106 equally parsimonious trees. Numbers above the line refer to those clades mentioned in the text and table 3. The numbers below the line refer to the bremer support values for each clade.

Fig. 3. *Bathybadistes andrewsi* n. sp., A–D, male holotype (NIWA XXXX), E–F and H–I, female paratype (NIWA XXXX), G, male paratype (NIWA XXXX). A, dorsal view; B, lateral view; C, ventral oblique view of cephalon; D, dorsal view of cephalon; E, left antenna 2; F, left antenna 1; G, left antenna 1; H, left maxilla 1; I, left maxilla 2. Habitus scale bar = 1 mm.

Fig. 4. *Bathybadistes andrewsi* n. sp., female paratype (NIWA XXXX). A, left mandible; B, right mandible; C, right pereopod 1; D, unguis of right pereopod 1; E, left maxilliped; F, distal part of endite of left maxilliped; G, left pereopod 5.

Fig. 5. *Bathybadistes andrewsi* n. sp., A, D–H, female paratype (NIWA XXXX), B–C, I, male paratype (NIWA XXXX). A, left pereopod 7; B, pleopod 1; C, left pleopod 2; D, operculum; E, right pleopod 3; F, right pleopod 4; G, right pleopod 5; H, right uropod; I, ventral view of pleon.

Fig. 6. *Bathybadistes andrewsi* n. sp. A, the operculum *in situ*. The inset is a higher magnification of the medial keel showing the scales, this surface is notably different to the smoother surface either side; B, dorsal spines and setae (which have been affected by the dehydration process) on the anterior pereonites. Notice the difference in scales when comparing the spines to the dorsal surface;

C, distally pappose setae on the mesial margin of article 3 of the maxilliped palp; D, a close-up of a distally pappose seta; E, the rudimentary exopod embedded into the uropodal protopod.

Fig. 7. *Bathybadistes fragilis* n. sp., male holotype (ZMH K-40785). A, lateral view; B, dorsal view; C, frontal view of cephalon; D, dorsal view of anterior half; E, oblique frontal view of cephalon; F, ventral view of pleon; G, dorsal view of pleon. Habitus scale bar = 1 mm.

Fig. 8. *Bathybadistes fragilis* n. sp., male holotype (ZMH K-40785). A, left maxilla 1; B, left maxilla 2; C, left maxilliped; D, left mandible; E, lateral view of left mandible.

Fig. 9. *Bathybadistes fragilis* n. sp., male holotype (ZMH K-40785). A, left pereopod 1; B, basis of left pereopod 2; C, basis of left pereopod 3; D, basis of left pereopod 4; E, left uropod; F, left pleopod 3; G, left pereopod 4; H, left pereopod 5.

Fig. 10. *Bathybadistes fragilis* n. sp., male holotype (ZMH K-40785). A, left pereopod 5; B, left pereopod 6, C, left pereopod 7.

Fig. 11. *Bathybadistes fragilis* n. sp., male holotype (ZMH K-40785). A, left antenna 1; B, lateral view of left antenna 1; C, pleopod 1; D, lateral view of pleopod 1; E, pleopod 2; F, dorsal view of pleopod 2.

Fig. 12. *Bathybadistes spinosissima* (Hansen, 1916), A–E, female syntype (ZMUC CRU 9248), F–G, male syntype (ZMUC CRU 8212). A, dorsal view; B, lateral view; C, ventral view of cephalon and mouthparts; D, ventral view of pleon; E, ventral oblique view of pleon; F, ventral view of pleon and posterior pereonites; G, ventral view of cephalon and mouthparts. Habitus scale bar = 1 mm.

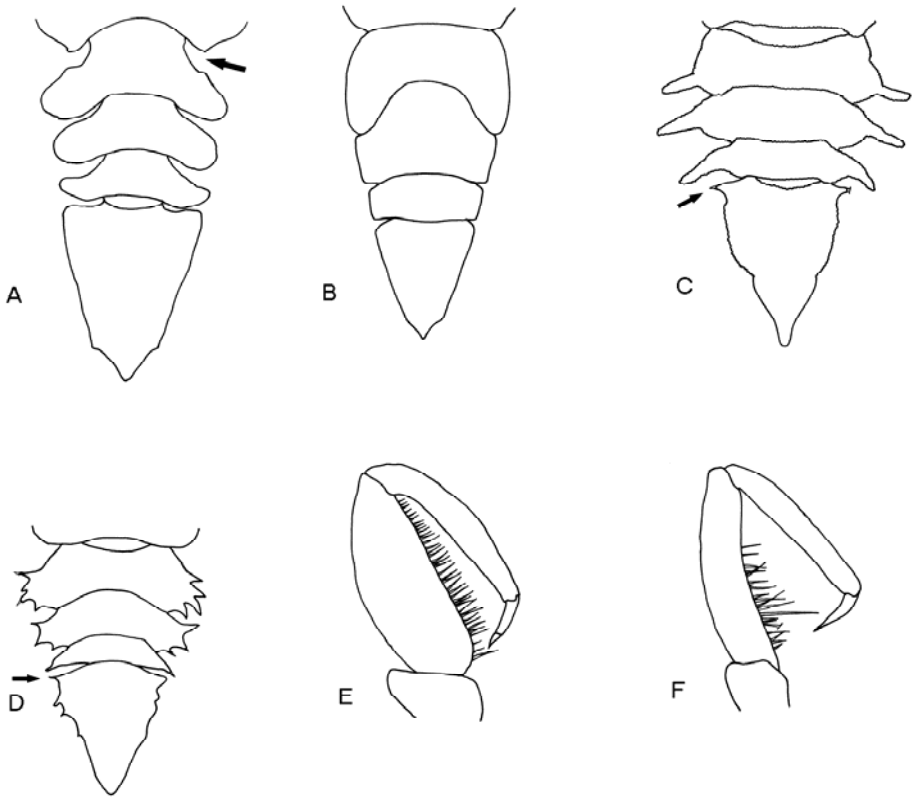

Fig. 1

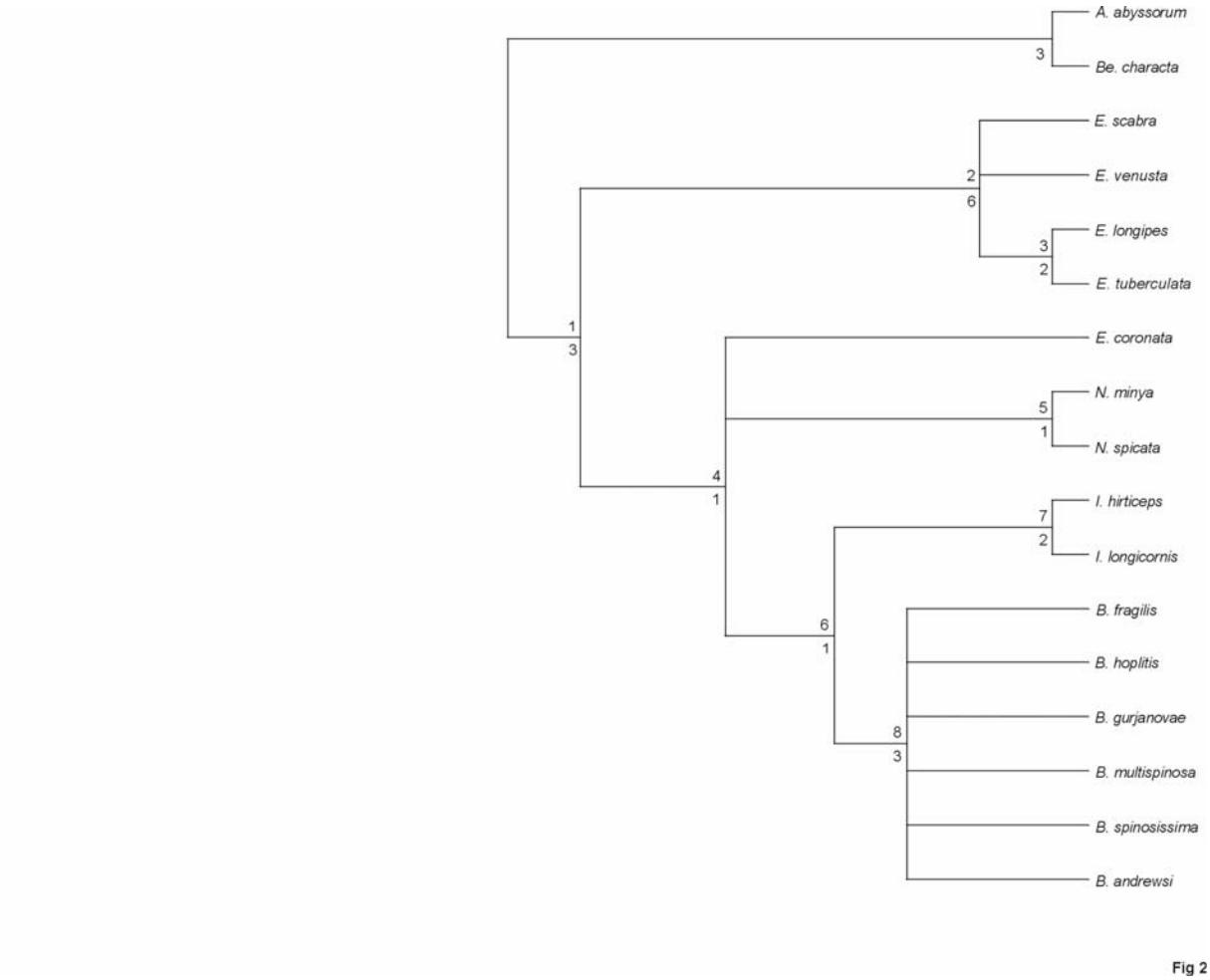
A. abyssorum
Be. characta
E. scabra
E. venusta
E. longipes
E. tuberculata
E. coronata
N. minya
N. spicata
I. hirticeps
I. longicornis
B. fragilis
B. hoplitis
B. gurjanovae
B. multispinosa
B. spinosissima
B. andrewsi
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Fig 2

Fig 2

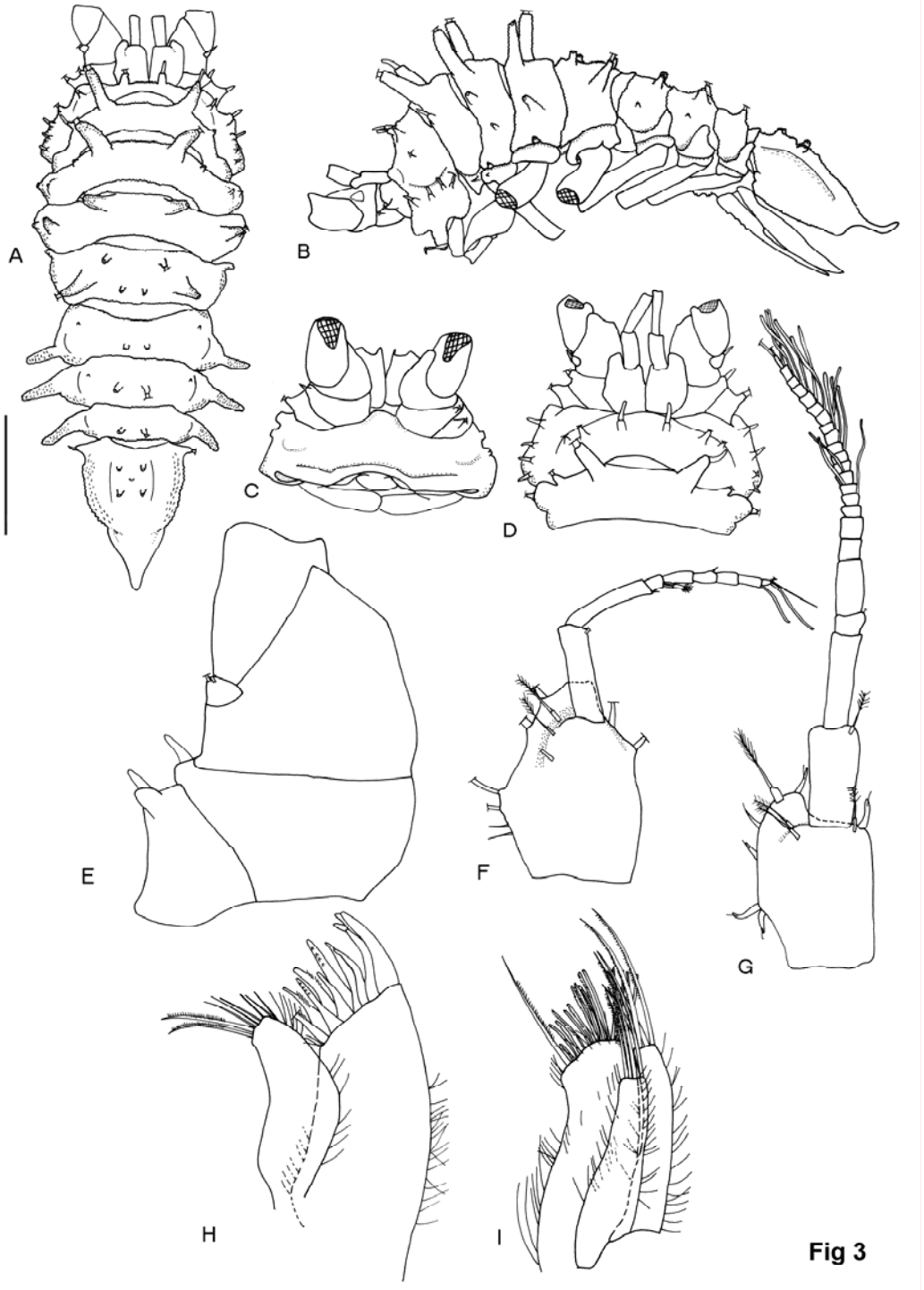

Fig 3

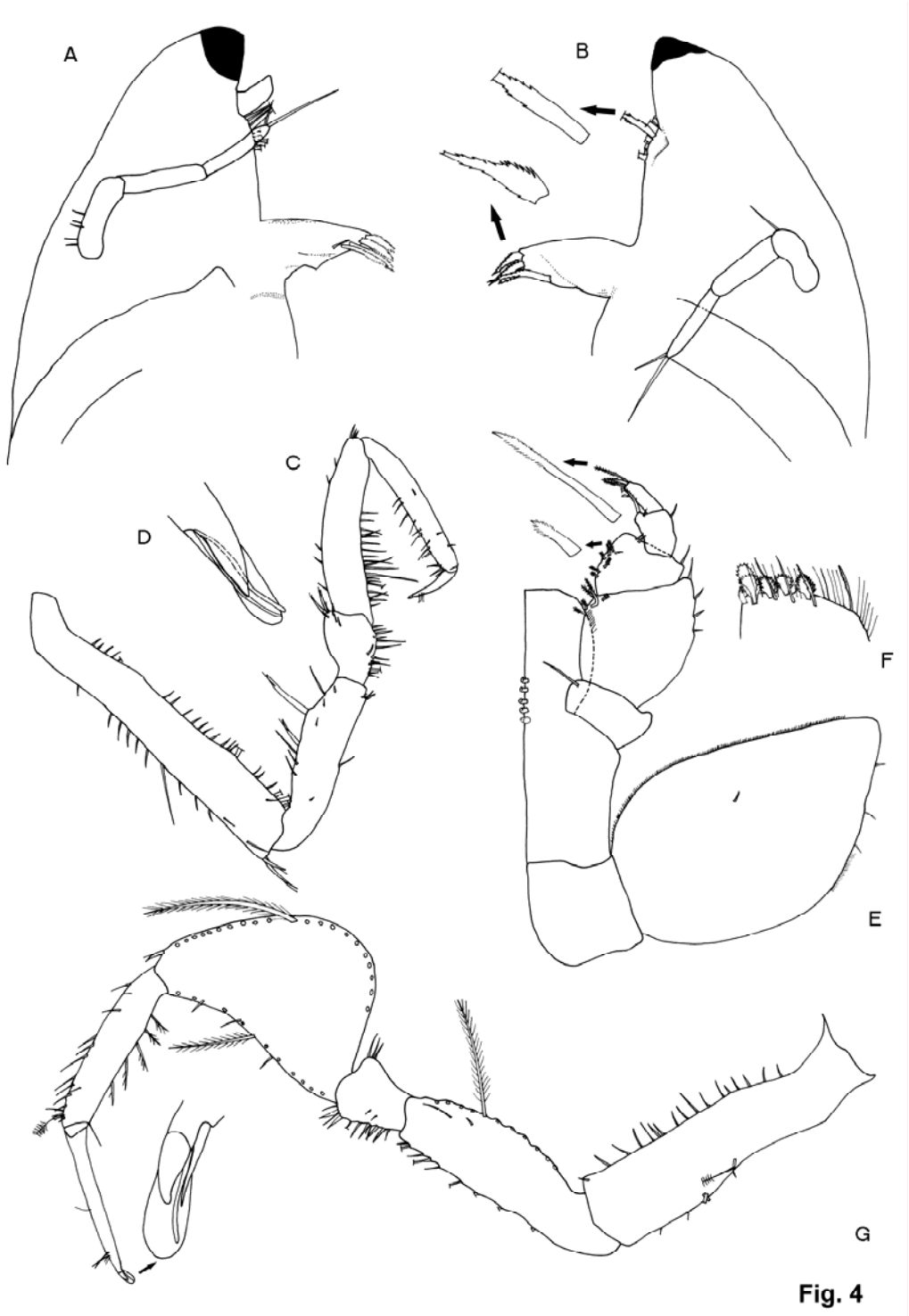

Fig. 4

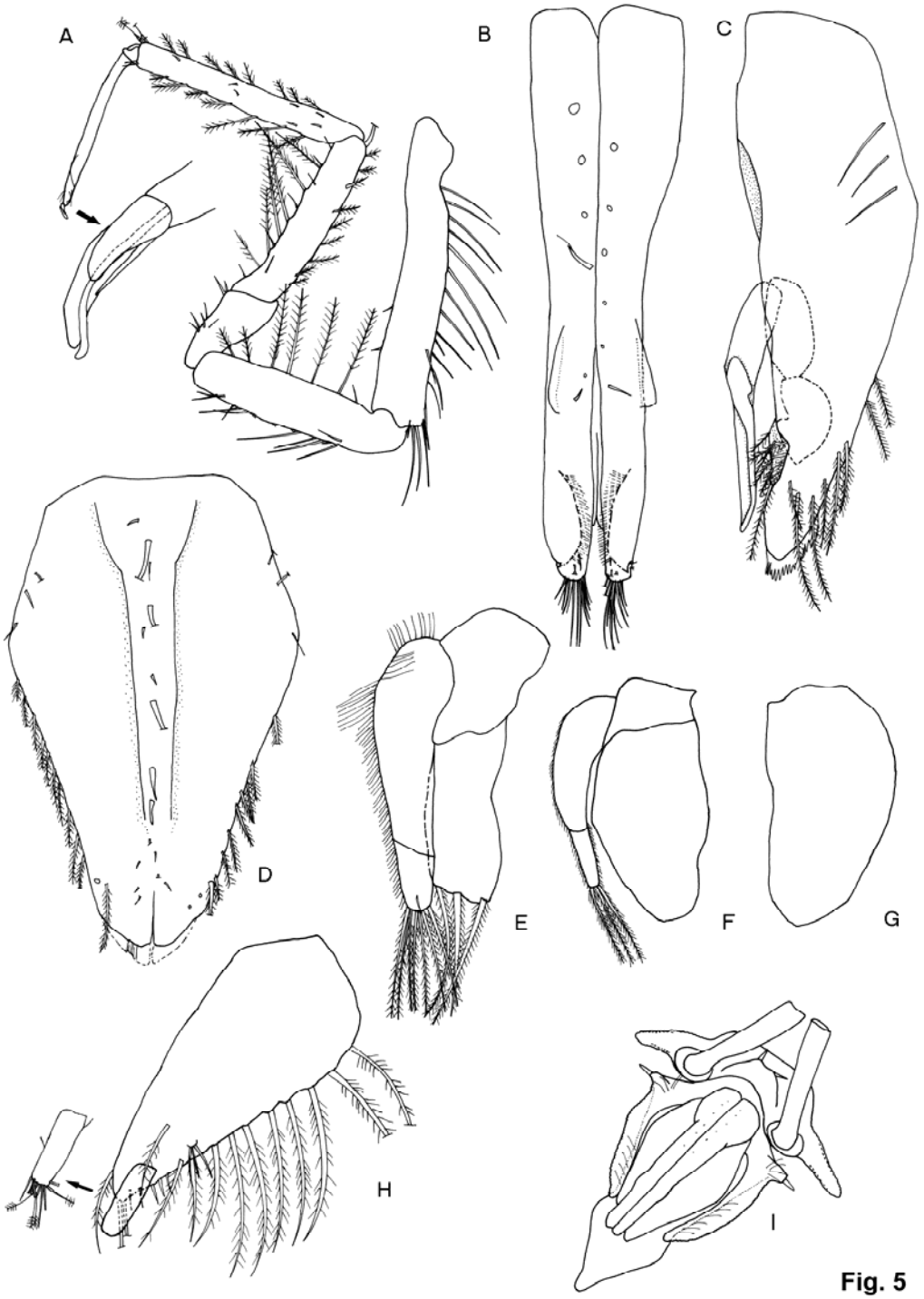

Fig. 5

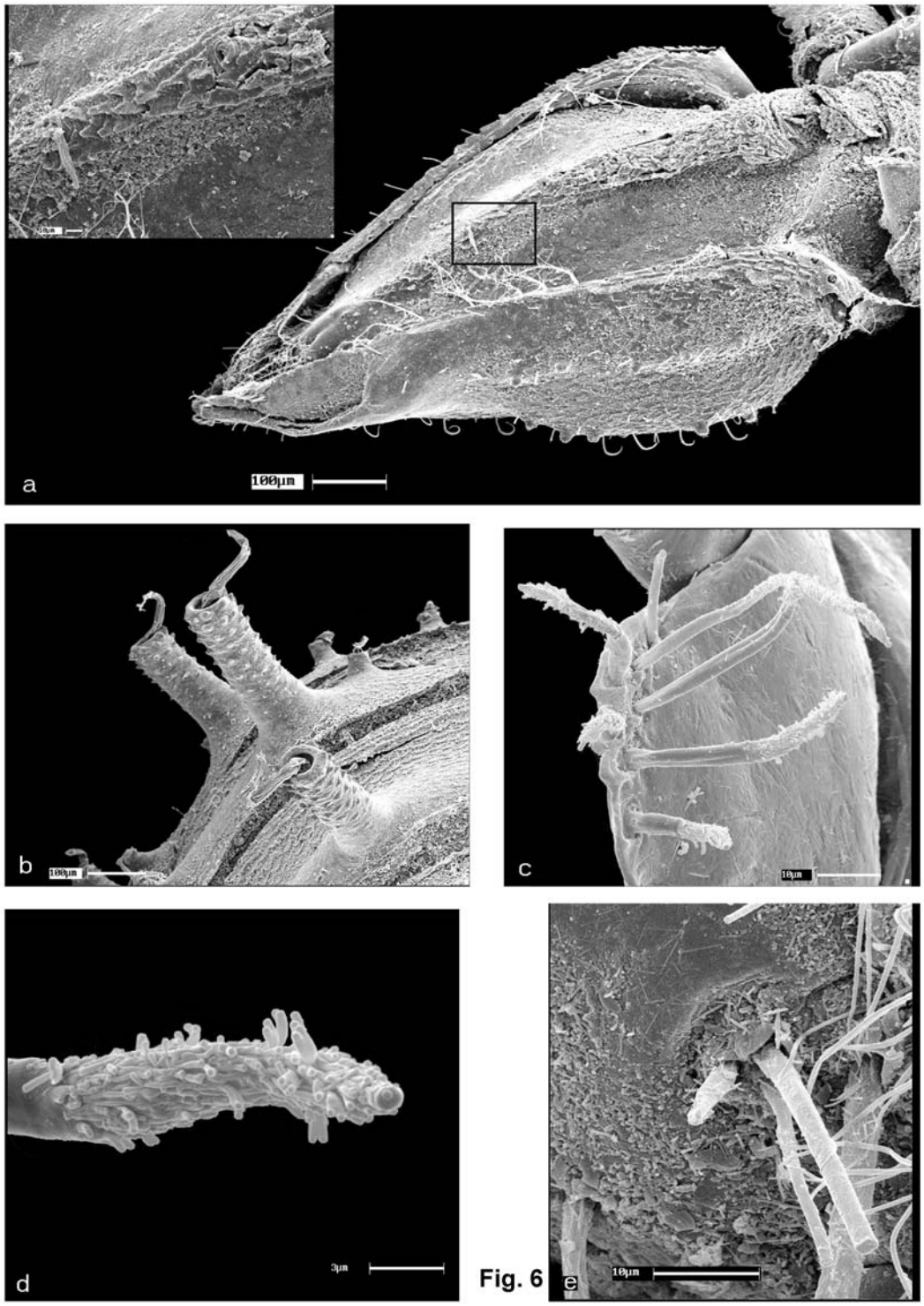

Fig. 6

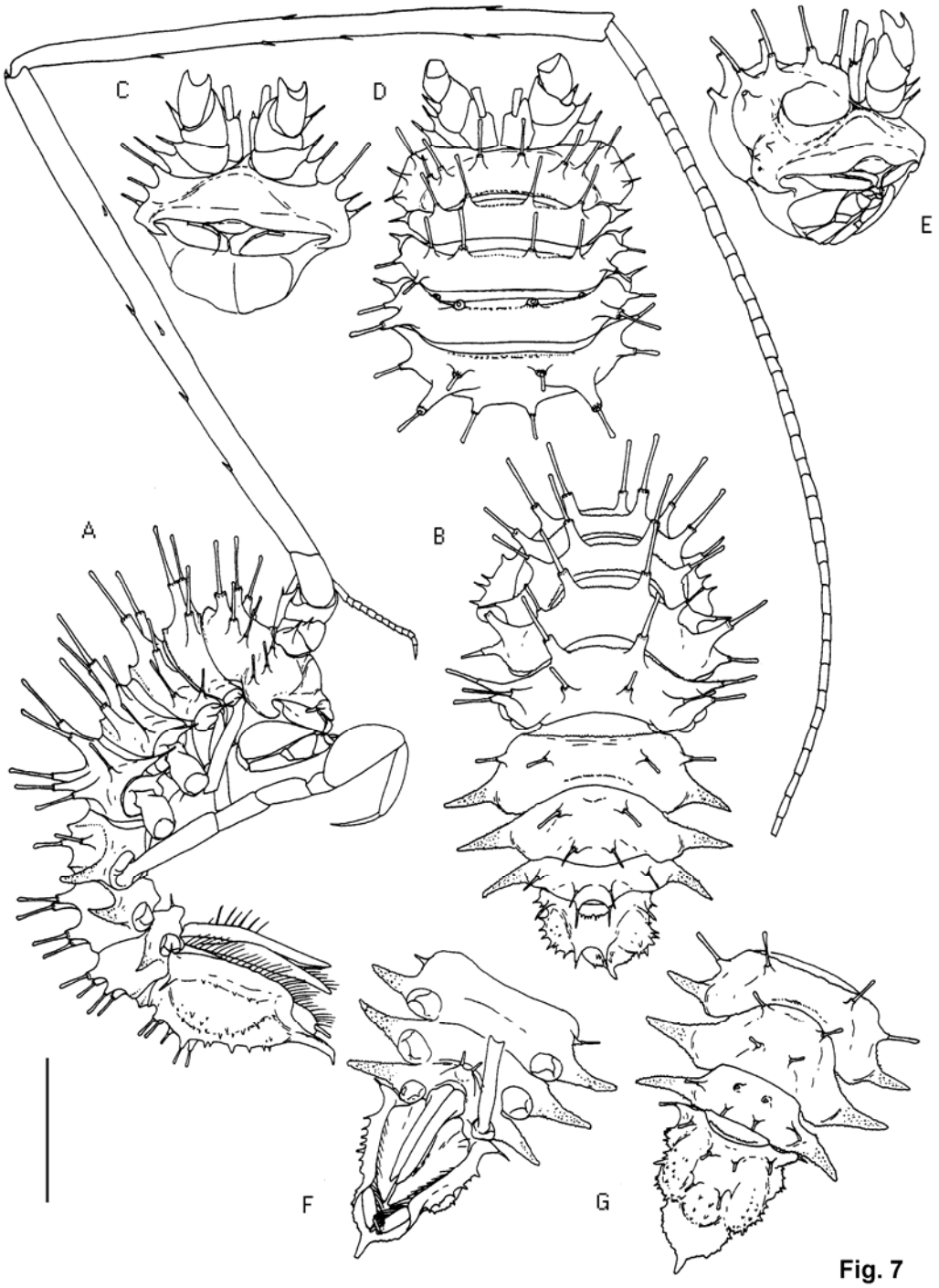

Fig. 7

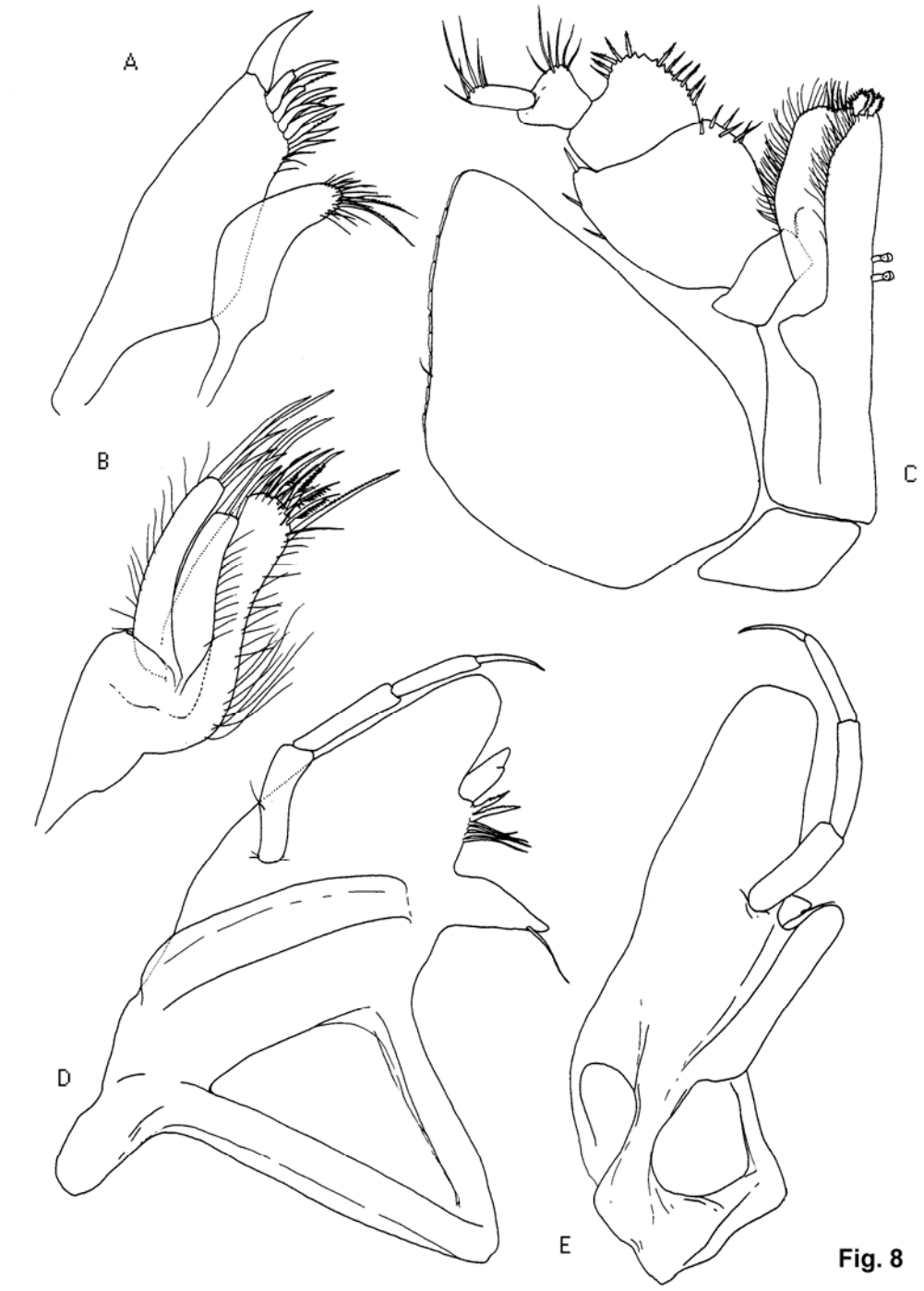

Fig. 8

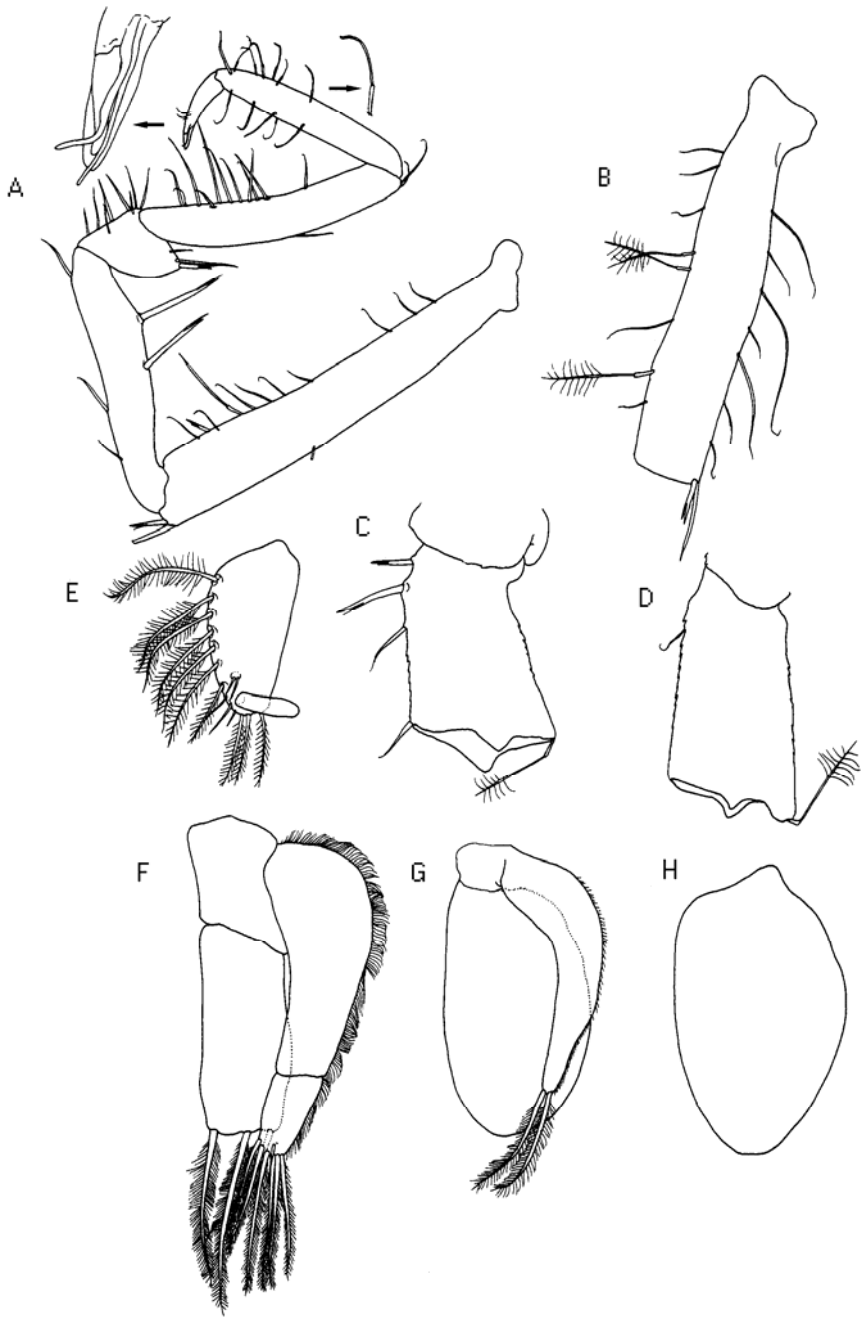

Fig. 9

Fig. 10

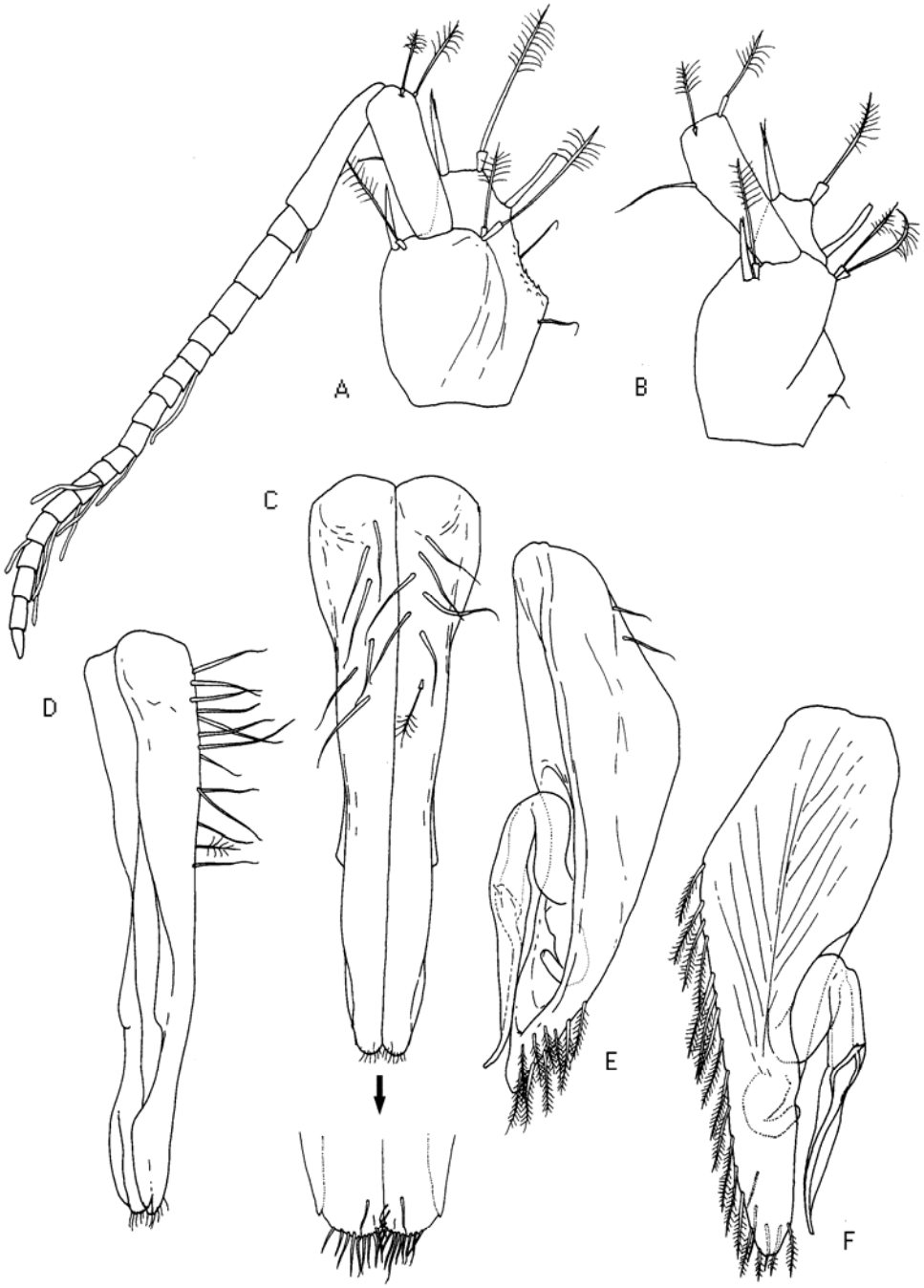

Fig. 11

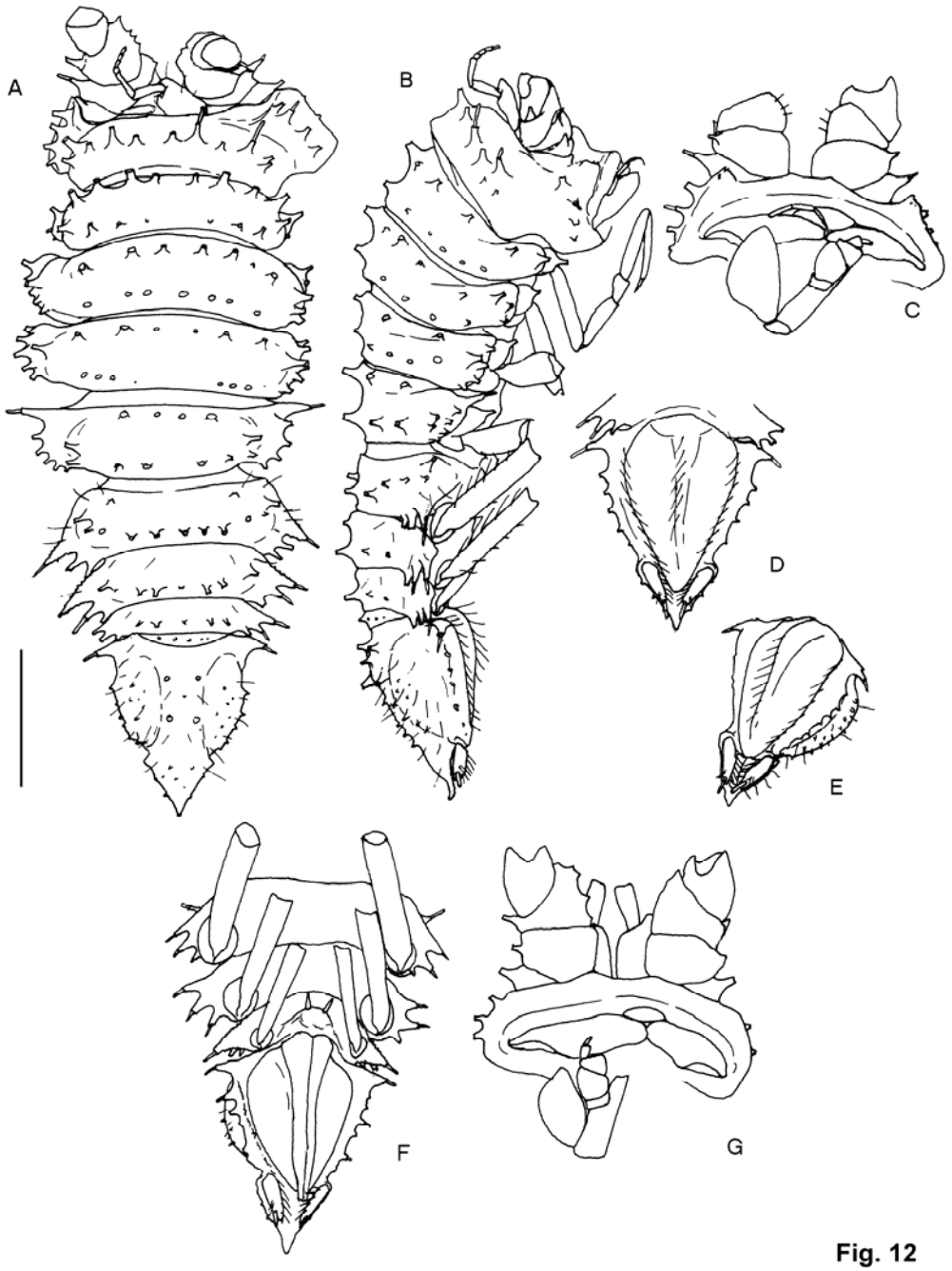

Fig. 12